

Trial Examination 2018

## VCE Biology Units 3&4

Written Examination

### Question and Answer Booklet

Reading time: 15 minutes  
Writing time: 2 hours 30 minutes

Student's Name: \_\_\_\_\_

Teacher's Name: \_\_\_\_\_

#### Structure of booklet

| <i>Section</i> | <i>Number of questions</i> | <i>Number of questions to be answered</i> | <i>Number of marks</i> |
|----------------|----------------------------|-------------------------------------------|------------------------|
| A              | 40                         | 40                                        | 40                     |
| B              | 10                         | 10                                        | 80                     |
|                |                            |                                           | Total 120              |

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.

Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

No calculator is allowed in this examination.

#### Materials supplied

Question and answer booklet of 33 pages

Answer sheet for multiple-choice questions

#### Instructions

Write your **name** and your **teacher's name** in the space provided above on this page, and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

All written responses must be in English.

#### At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet.

**Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.**

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2018 VCE Biology Units 3&4 Written Examination.

Neap Trial Exams are licensed to be photocopied or placed on the school intranet and used only within the confines of the school purchasing them, for the purpose of examining that school's students only. They may not be otherwise reproduced or distributed. The copyright of Neap Trial Exams remains with Neap. No Neap Trial Exam or any part thereof is to be issued or passed on by any person to any party inclusive of other schools, non-practising teachers, coaching colleges, tutors, parents, students, publishing agencies or websites without the express written consent of Neap.

## SECTION A – MULTIPLE-CHOICE QUESTIONS

### Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

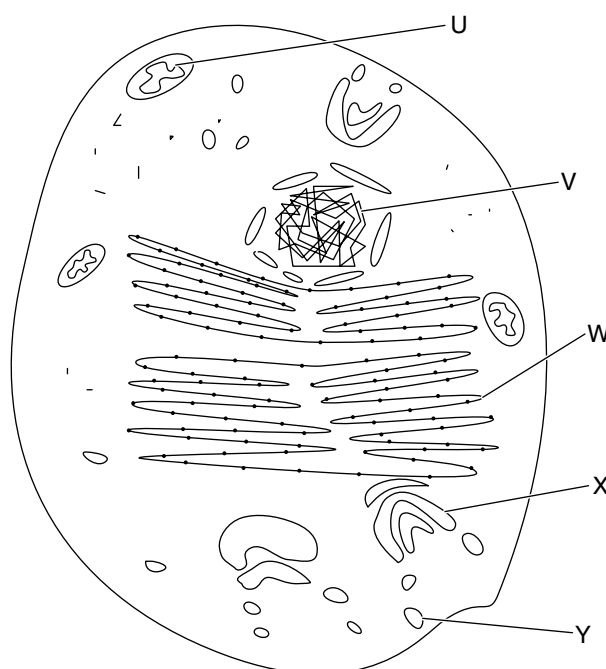
Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

### Question 1

A typical secretory cell is illustrated below. Structures U to Y show various organelles involved in the manufacture of a protein for secretion.



Which of the following statements most correctly associates structure and/or function of the labelled structures?

- A. The ribosomes on structure W and the chromatin in structure V are both membrane bound.
- B. Structures X and Y are involved in the packaging and endocytosis of a secretory product.
- C. The order of structure involvement with the synthesis, transport and secretion of the protein would be structure V → structure U → structure Y.
- D. Structure U contains a compartmentalised matrix containing a range of enzymes to ensure efficient metabolism.

**Question 2**

About two billion years ago, an aerobic prokaryote was engulfed by a cell for food. However, rather than being digested, the cell offered the aerobic prokaryote protection and in return the aerobic prokaryote provided a great deal of energy in the form of ATP for the cell that consumed it. Over time the mitochondrion appeared in eukaryotic cells as an organelle.

The information outlined in the paragraph above supports the

- A. cell theory.
- B. endosymbiotic theory.
- C. bacterial origin of the nucleus.
- D. endocytosis theory.

**Question 3**

In a single cell within a multicellular individual, the

- A. genome is proportionally smaller than the proteome.
- B. genome is different in each cell within the multicellular individual.
- C. proteome can vary from cell to cell depending on its location within the multicellular individual.
- D. proteome is the same in individual cells for the life of the cell.

**Question 4**

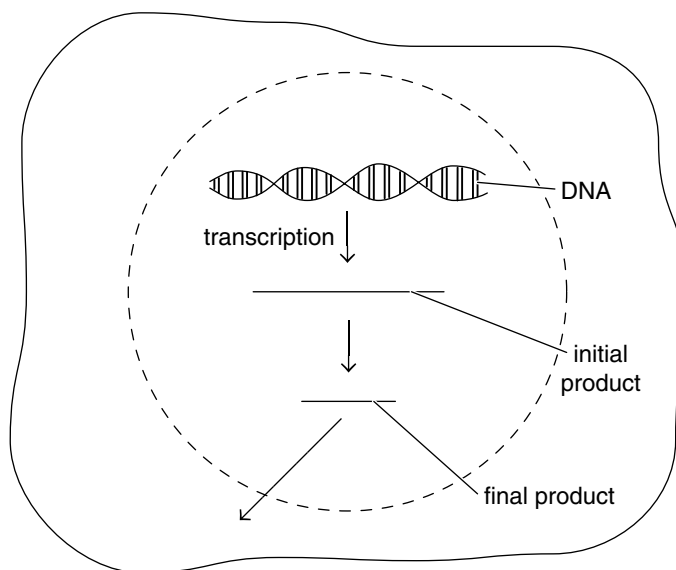
ATP synthase catalyses the conversion of ADP into ATP in the mitochondria as well as in the chloroplast. The ATP synthase is made up of more than ten polypeptide chains that work collectively to form a functional protein.

ATP synthase works

- A. at the quaternary level.
- B. to hydrolyse ATP.
- C. at the tertiary level.
- D. because of the large number of  $\alpha$ -helices within each polypeptide chain.

**Question 5**

The diagram below represents a simplified version of transcription. Following this, RNA processing occurs where the initial product of transcription is converted into a final product prior to the export of that product from the nucleus.



The reason that the final product of RNA processing is smaller than the initial product is that

- A. exons are spliced out, leaving only introns as the final product.
- B. the degeneracy of the code allows for a smaller final product.
- C. room needs to be made to add the methylated cap and poly-A tail.
- D. the spliceosome removes introns from the initial product.

**Question 6**

During the synthesis of polypeptides, the molecules closely associated with the ribosome include

- A. mRNA and tRNA, but not rRNA.
- B. mRNA and amino acids, but not tRNA.
- C. anticodons, codons and rRNA.
- D. mRNA, tRNA and rRNA.

*Use the following information to answer Questions 7 and 8.*

A particular brand of washing powder has the following information on the packaging.

- Contains protease and lipase.
- Works best at 40°C.
- One cup of powder for a normal load of 20 L.

**Question 7**

The substrates involved in the enzyme-catalysed reactions within a load of washing using this particular brand of washing powder would be

- A. protein and lipids.
- B. protease and lipase.
- C. amino acids and fatty acids.
- D. protein, protease, lipids and lipase.

**Question 8**

For the fastest wash it would be recommended to use

- A. two cups of powder in a normal load of 20 L at a temperature of 60°C.
- B. a half-cup of powder in a 10 L load at a temperature of 40°C.
- C. two cups of powder in a normal load of 20 L at a temperature of 40°C.
- D. two cups of powder in a load of 40 L at a temperature of 10°C.

**Question 9**

The light-dependent reaction occurs in the

- A. thylakoid membrane and the lumen of the grana of a chloroplast.
- B. matrix of the chloroplast.
- C. stroma of the chloroplast.
- D. intermembrane space of the mitochondria.

*Use the following information to answer Questions 10–12.*

Spinach leaves are a good model for photosynthesis experiments. To prepare the leaves, small circular sections of leaf are removed from a plant using a punch biopsy tool. The leaf sections are exposed to a vacuum to remove any air bubbles from within the leaf. Several leaf sections were generated and exposed to a variety of conditions thought to influence the rate of photosynthesis. The rate of photosynthesis was measured by timing how long it took the leaf sections to fill with air and float to the surface of a 100 ml measuring cylinder filled with water. The data collected is shown in the table below.

| Factor being varied | Time taken for leaf sections to rise (minutes) |         |         |         |
|---------------------|------------------------------------------------|---------|---------|---------|
|                     | Trial 1                                        | Trial 2 | Trial 3 | Trial 4 |
| Light (none)        | 2.5                                            | 2.8     | 3.1     | 2.4     |
| Light (dim)         | 1.2                                            | 1.3     | 1.5     | 1.3     |
| Light (bright)      | 0.8                                            | 0.7     | 0.8     | 0.7     |
| Temperature (cold)  | 2.1                                            | 2.3     | 2.1     | 2.1     |
| Temperature (warm)  | 0.4                                            | 0.5     | 0.5     | 0.4     |

### Question 10

Appropriate controlled conditions for the experiment testing the effect of warm temperatures on the rate of photosynthesis would include

- A. bright light, different numbers of leaf sections and volume of water in the measuring cylinder.
- B. dim light, the same number of leaf sections and varying volumes of water in the measuring cylinder.
- C. species of spinach, the size of the leaf sections and no light.
- D. bright light, the same number of leaf sections and the same sized leaf sections.

### Question 11

The data collected was

- A. imprecise.
- B. qualitative.
- C. repeated.
- D. accurate.

### Question 12

A suitable conclusion that could be drawn from the data obtained in this series of experiments would be that

- A. plants need bright light to carry out photosynthesis.
- B. bright light and warm conditions lead to more efficient photosynthesis.
- C. warm temperatures provide conditions for photosynthesis that are twice as efficient as the conditions provided in dim light.
- D. the light-independent reactions of photosynthesis will still occur in darkness.

**Question 13**

One type of signalling molecule is called androstenone, which is released from the saliva of male pigs into the air. The androstenone binds to receptors in a female pig's olfactory nerves and stimulates a reproductive behavioural response.

This scenario is consistent with the

- A. signalling molecule being a type of neurotransmitter.
- B. signalling molecule being lipid soluble.
- C. signalling molecule being a type of hormone.
- D. action of pheromones.

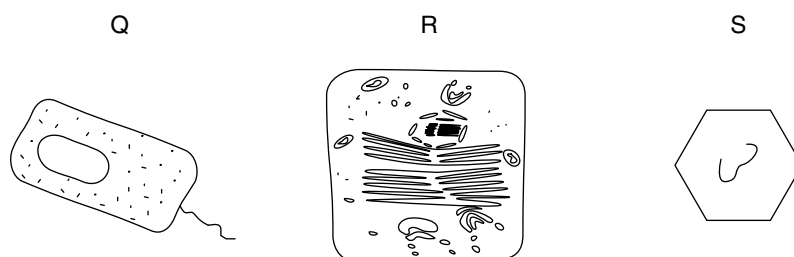
**Question 14**

External apoptotic signals on a target cell could be

- A. cytokine.
- B. mitochondrial-stress related.
- C. phagocytic.
- D. activated by genes within cells that are within a gland far from the target cell.

**Question 15**

The following diagram shows three pathogens (Q, R and S).



How could these pathogens be best described?

|    | Q                 | R                 | S                 |
|----|-------------------|-------------------|-------------------|
| A. | pathogenic agent  | cellular pathogen | prokaryotic       |
| B. | prokaryotic       | cellular pathogen | pathogenic agent  |
| C. | cellular pathogen | pathogenic agent  | prokaryotic       |
| D. | pathogenic agent  | prokaryotic       | cellular pathogen |

**Question 16**

Components of the lymphatic system include the

- A. lymph nodes, spleen, bones and thyroid.
- B. lymph, spleen, lymph nodes and kidney.
- C. blood, liver, spleen and brain.
- D. lymph nodes, spleen, lymph ducts and thymus.

**Question 17**

The human body has the capacity to distinguish between self and non-self as a way of ensuring good immunological health.

What would be an example of where the immune system relies on this phenomenon?

- A.** The same self-markers are found on the surface of transplanted cells from a donor, so the transplanted cells are not rejected by the recipient.
- B.** Antigens on the surface of a HIV virus are ignored by the immune system.
- C.** Antibodies on the surface of a bacterial pathogen bind to specific antigens in the blood plasma.
- D.** Self-markers are located on the surface of all cells within a multicellular organism.

**Question 18**

Clonal selection was the term used to describe the active immune response when it was discovered by Sir Frank Macfarlane Burnet during the late 1950s.

Clonal selection involves

- A.** naive B cell receptors binding to a specific antigen.
- B.** naive T cells differentiating into memory B cells.
- C.** mature B cells differentiating into mature T cells.
- D.** the genes within B cells undergoing change in the introns and exons, so that the secreted antibodies will have a complementary shape to the antigen.

Use the following information to answer Questions 19 and 20.

In Australia, it is estimated that any human has a 90% chance of coming into contact with the Human Papilloma Virus (HPV), and as a result it is the most common sexually transmitted disease. From 2018, a government-subsidised campaign will be in place to provide young men and women access to vaccinations against the nine most likely strains that cause HPV, which in some cases can lead to cancer. There will be two vaccines given at least two months apart.

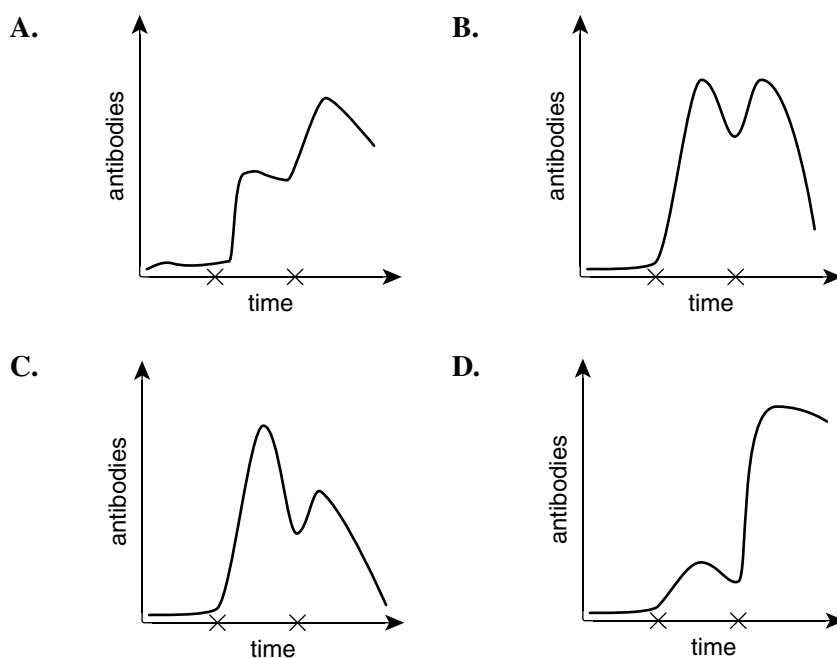
### Question 19

This type of government-subsidised campaign could best be described as

- A. the best way to generate natural passive immunity.
- B. an effective way to provide herd immunity.
- C. a passive form of active immunity.
- D. a method to eradicate all forms of HPV induced cancers.

### Question 20

Which one of the following graphs would show the level of antibodies in the bloodstream against the HPV antigens over the duration of the recommended vaccine program?



*Use the following information to answer Questions 21 and 22.*

Allergic reactions are a normal immune response to foreign invaders. Their purpose is to expel the foreign particles, which is why airborne allergies make us sneeze, have a runny nose, or have watery eyes, while allergies to food often trigger diarrhoea. If the allergen was a harmful organism it makes perfect sense, but most of the proteins that trigger allergic reactions are quite harmless. However, allergens generally have similarities to antigens that represent harm, such as those found on the surface of parasitic worms. Immunologists suspect that the reason we have allergies could be because the immune system has evolved to recognise these proteins and react to them.

**Question 21**

The symptoms of an allergy are activated by

- A. mast cells being released from macrophages.
- B. histamines being released from lymphocytes.
- C. T memory cells releasing antibodies.
- D. mast cells secreting histamines.

**Question 22**

Without treatment, the body's response to allergies such as the type described

- A. places the human at a selective advantage as they are more likely to survive the exposure.
- B. places the human at a selective disadvantage because the allergen is not in the body long enough to elicit a response.
- C. would not relate to evolution because the allergen is not a pathogen.
- D. could lead to the death of the human because the airways could become too narrow and the diarrhoea would lead to severe dehydration.

**Question 23**

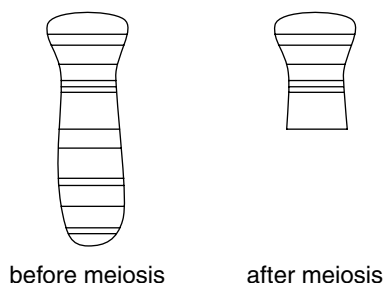
Two geographically isolated, evolving populations move back into each other's habitats after an extended period of isolation.

If the populations are no longer able to successfully reproduce, the process being described is called

- A. allopatric speciation.
- B. gene flow.
- C. artificial breeding.
- D. the founder effect.

**Question 24**

When a chromosome's structure is altered (and passed onto the next generation), it is a type of mutation. Most of these types of mutation occur during the development of sperm and ova during the process of meiosis. Wolf-Hirschhorn Syndrome is a rare disorder that develops as a result of a chromosome mutation along chromosome 4. A diagram showing chromosome 4 prior to meiosis and the chromosome after meiosis is illustrated below.

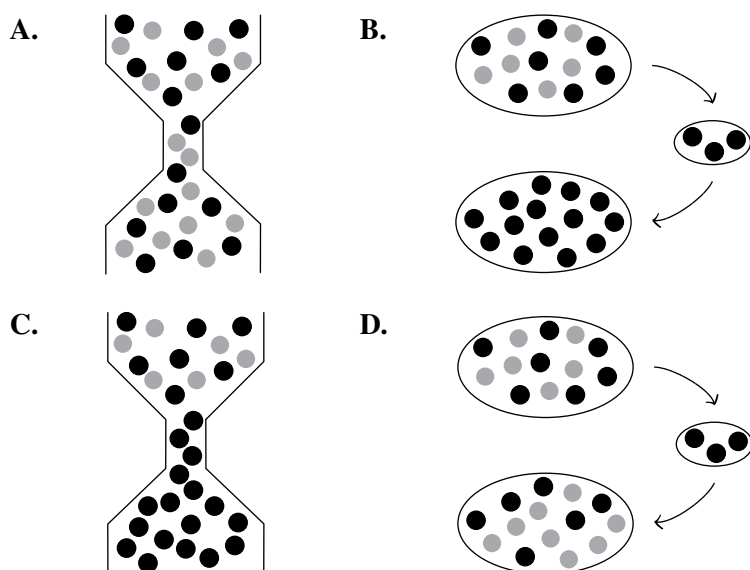


The type of mutation demonstrated is a

- A. point mutation.
- B. single-gene inversion.
- C. many-gene translocation.
- D. multi-gene deletion.

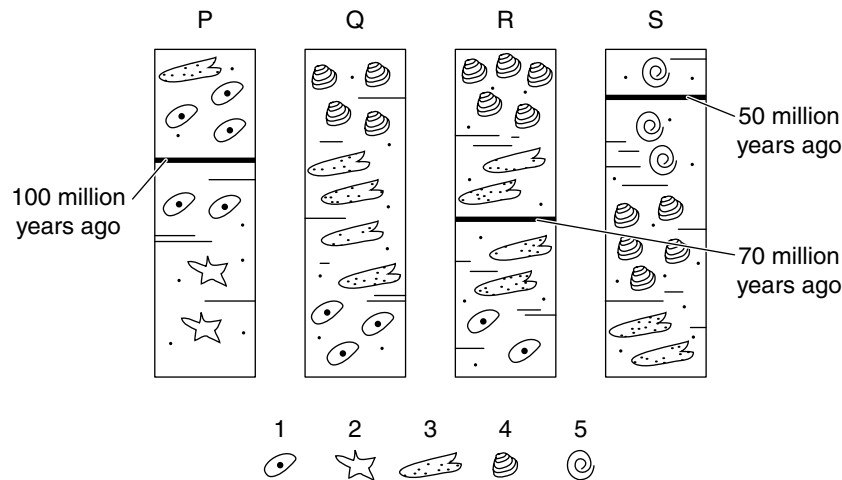
**Question 25**

Which of the following diagrams best represents how the bottleneck effect could randomly change a gene pool?



**Question 26**

The diagram below illustrates the strata layering in four areas (P, Q, R and S), as well as the fossils (1, 2, 3, 4 and 5) located in some of the strata layers. Several layers of volcanic rock were absolutely dated, which give an idea of the time periods in which each of the fossils existed.



It would be reasonable to say that

- A. fossil 4 existed over one hundred million years ago.
- B. the order of fossils by age (from youngest to oldest) is 3, 1, 5, 4 and 2.
- C. fossil 3 only existed between fifty and seventy million years ago.
- D. area S contains the most recent fossils.

**Question 27**

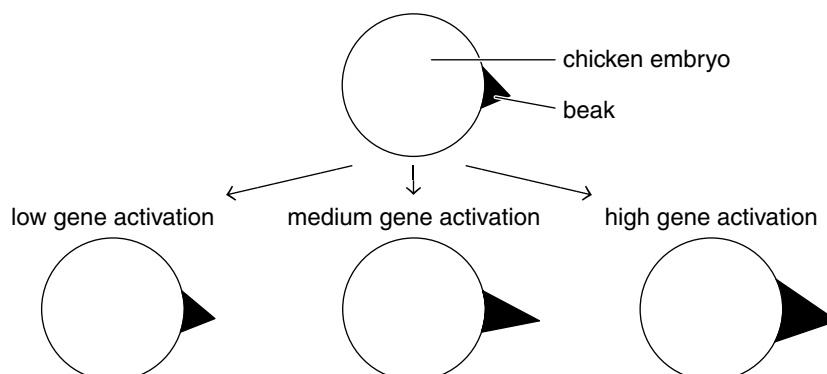
Potassium-40 has a half-life of 1.3 billion years and is commonly used to date very old volcanic rock. The oldest rocks dated on Earth have been dated to be 4.6 billion years old using potassium-40 dating.

If there was 1 arbitrary unit of potassium-40 in the oldest volcanic rocks when they were formed, approximately how many units would be found to be in them today?

- A. 0.5 units
- B. 0.25 units
- C. 0.13 units
- D. 0.09 units

Use the following information to answer Questions 28 and 29.

The gene controlling beak formation in Galapagos finches has been extensively studied. The longer the gene is active during beak formation, the thicker and more robust the beak becomes. This was confirmed by researchers working with chicken embryos, as illustrated in the diagram below.



### Question 28

The name of the gene controlling beak development is called

- A. BNP4.
- B. BMP4.
- C. AMP4.
- D. BNP3.

### Question 29

Which one of the following statements would be appropriate when referring to the evolution of the beaks in the Galapagos finches?

- A. In an environment of small seeds, the factors controlling the duration of gene activation would change to ensure small beaks would form in the embryonic finches.
- B. The selective agent for the formation of beaks is the presence of predators such as killer whales.
- C. If the gene controlling beak formation is active for longer, the larger-beaked offspring will be at a survival advantage in an environment of large seeds.
- D. In an environment of a particular seed type, the genes controlling the formation of beaks will mutate to allow the most suited phenotype to prevail.

### Question 30

Organisms from the genus *Australopithecus*

- A. evolved after *Homo habilis*.
- B. existed about one million years ago.
- C. demonstrated that bipedalism evolved before cranial capacity enlargement.
- D. were never tree dwellers, as the African Savannah contained no trees.

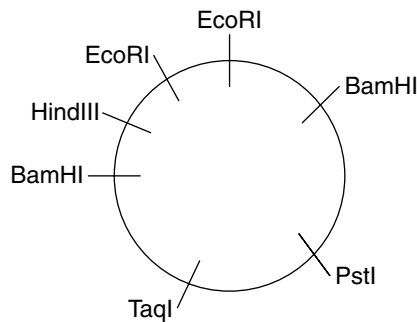
**Question 31**

DNA hybridisation involves

- A. comparing the temperature at which DNA double strands are denatured at a particular loci compared to the temperature at which hybridised strands from two individuals are denatured at the same loci.
- B. cutting the DNA with restriction enzymes and then mixing the strands from different species together.
- C. annealing denatured DNA strands using ligase.
- D. extracting DNA from different gene loci within different individuals and comparing the sequences of them.

**Question 32**

The following diagram illustrates the recognition sites on a plasmid for a variety of restriction endonucleases.



Which combination of restriction endonucleases would need to be added to produce three fragments of DNA?

- A. HindIII and BamHI
- B. TaqI
- C. PstI, BamHI and EcoRI
- D. EcoRI

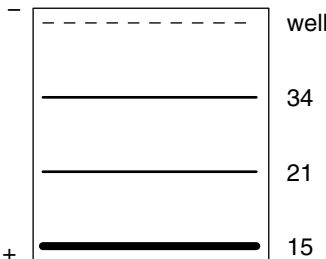
Use the following information to answer Questions 33 and 34.

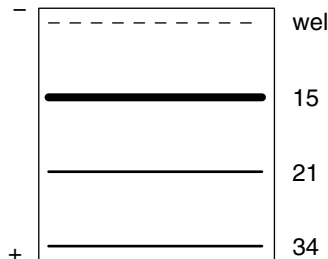
Restriction fragment length polymorphisms (RFLPs) are routinely used in genetic profiling cases where the identity of individuals is required, such as in criminal cases. The reason they are used is that individuals contain sections of DNA that vary in length when compared to other individuals. In the table below, four suspects were tested along with a sample of material from a crime scene. The numbers in the table represent the length of the DNA fragment at a particular locus.

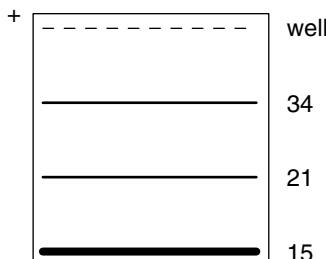
| Loci | Length of DNA fragment (×1000 of base pairs) |           |           |           |           |
|------|----------------------------------------------|-----------|-----------|-----------|-----------|
|      | Suspect 1                                    | Suspect 2 | Suspect 3 | Suspect 4 | Suspect 5 |
| 1    | 34                                           | 24        | 24        | 34        | 34        |
| 1    | 21                                           | 21        | 21        | 21        | 21        |
| 2    | 15                                           | 15        | 15        | 15        | 15        |
| 2    | 15                                           | 16        | 18        | 15        | 15        |

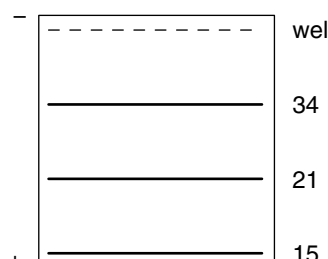
### Question 33

What would be the genetic profile of suspect 1 as seen after gel electrophoresis?

**A.** 

**B.** 

**C.** 

**D.** 

### Question 34

What is a reasonable conclusion that could be made with respect to the criminal case in question?

- In the general population, gene locus 2 would be less useful at determining uniqueness than gene locus 1.
- More gene loci should be investigated to determine which suspect can be associated with the crime scene.
- Suspect 1 and suspect 4 are identical twins who colluded together to commit a crime.
- The risk of contamination at the crime scene would be too high to allow any reasonable conclusion to be made.

**Question 35**

Canola crops have a distinctive yellow colour as they are growing. In 2017, about 25% of canola crops in Victoria were genetically modified. A gene from a soil bacterium has been spliced into the genome of canola plants conferring resistance to herbicides. This enables the farmer to improve productivity with the use of herbicide sprays. With any genetically modified product there are issues with their use, both positive and negative.

What would be an appropriate issue for and an appropriate issue against this specific genetic modification?

|    | Issue for                                                                                                           | Issue against                                                                                            |
|----|---------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| A. | The risk of cross-pollination is minimised as the yellow canola flowers are sterile.                                | As the canola plants are not transgenic, they pose no threat to humans.                                  |
| B. | The use of genetically modified canola is not harmful to the environment or the consumer of the product.            | The annual purchase of canola seeds would be more expensive compared to using non-modified seeds.        |
| C. | As 25% of canola crops are genetically modified, this is a clear indicator of the acceptance of this technology.    | The genetic variation between genetically modified canola plants is low, which is not good for survival. |
| D. | The farmers using genetically modified canola stand to make a greater profit when selling the product to consumers. | The use of herbicides could be detrimental to the environment in which the canola is growing.            |

**Question 36**

A pathogen was tested in the following ways:

- microscopy of infected tissue illustrated no cellular pathogen was present.
- infected tissue was exposed to factors that selectively destroyed nucleic acid, the symptoms of the disease remained.
- proteins were selectively destroyed in infected tissue, the symptoms of the disease were stopped.

Based on this information, the type of pathogen is

- A. unicellular.
- B. a prion.
- C. prokaryotic.
- D. viral.

**Question 37**

Neuraminidase is

- A. an enzyme that allows the influenza virus to enter cells.
- B. a drug that blocks the action of the haemagglutinin antigen on the surface of the influenza virus.
- C. sensitive to the action of Relenza, thus stopping the influenza virus from exiting infected cells.
- D. a drug that blocks the action of haemagglutinin.

*Use the following information to answer Questions 38–40.*

An experiment was conducted investigating the effect of increasing oxygen concentration on the length of carrot tubers. The data collected is illustrated in the table below.

| Oxygen level | Length of carrot tuber (cm) |
|--------------|-----------------------------|
| Low          | 20                          |
| Medium       | 40                          |
| High         | 60                          |

**Question 38**

The independent variable in this experiment is the

- A. oxygen level.
- B. length of carrot tuber.
- C. temperature of the environment.
- D. low oxygen level.

**Question 39**

The type of graph that should be used to present this data should be a

- A. scatter plot.
- B. line graph.
- C. bar graph.
- D. histogram.

**Question 40**

A problem associated with the design of this particular experiment would be

- A. the presence of a control.
- B. a method that is ethically unacceptable.
- C. a lack of repeatability.
- D. that the data collected was qualitative.

**END OF SECTION A**

**SECTION B****Instructions for Section B**

Answer **all** questions in the spaces provided. Write using blue or black pen.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

**Question 1** (9 marks)

Membranes make up less than 1% of the gross molecular contents of a typical eukaryotic cell; however, their importance cannot be ignored.

**a. i.** Draw a labelled diagram of a typical cell membrane that shows the following: 3 marks

- at least **six** phospholipids
- **two** cholesterol molecules
- **one** protein channel and **one** glycoprotein.

**ii.** Membrane structure and function can be explained by the fluid mosaic model of membranes.

Explain how the behaviour of **two** of the components labelled in **part a. i.** relate to this model.

2 marks

---

---

---

---

- b.** Facilitated diffusion is one way some molecules are transported across membranes. The rate of the process is dependent on a variety of factors such as temperature and the number of transport channels.

- i.** Explain the effect temperatures above the optimum would have on the function of the protein channels.

2 marks

---

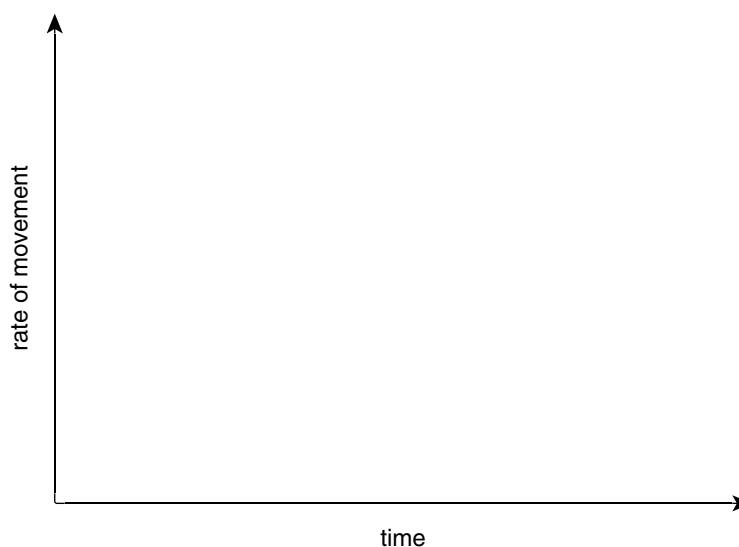
---

---

---

- ii.** On the axes below, draw a line(s)/curve(s) that shows the effect that increasing the concentration of protein channels has on the movement of a specific chemical across the membrane. Assume the chemical is in surplus and that at the start of the experiment the rate of movement was zero.

2 marks



**Question 2** (10 marks)

The following DNA template strand represents the first eighteen nucleotides of the CD28 gene (an important T cell gene), which was the target of a drug called TGN1412 that was used in clinical trials in 2006.

**3' TACGCATGAGCTAGCTAG 5'**

- a. i.** What do the 3' and 5' represent? 1 mark

---



---

- ii.** What is the mRNA sequence that the template strand above provides a blueprint for? 1 mark

---



---

- b.** The following table shows the mRNA amino acids.

|            |   | second base                                     |                                      |                                           |                                               |                  |
|------------|---|-------------------------------------------------|--------------------------------------|-------------------------------------------|-----------------------------------------------|------------------|
|            |   | U                                               | C                                    | A                                         | G                                             |                  |
| first base | U | UUU } phe<br>UUC }<br>UUA } leu<br>UUG }        | UCU }<br>UCC } ser<br>UCA }<br>UCG } | UAU } tyr<br>UAC }<br>UAA } stop<br>UAG } | UGU } cys<br>UGC }<br>UGA } stop<br>UGG } trp | U<br>C<br>A<br>G |
|            | C | CUU }<br>CUC } leu<br>CUA }<br>CUG }            | CCU }<br>CCC } pro<br>CCA }<br>CCG } | CAU } his<br>CAC }<br>CAA } gln<br>CAG }  | CGU }<br>CGC } arg<br>CGA }<br>CGG }          | U<br>C<br>A<br>G |
|            | A | AUU }<br>AUC } ile<br>AUA } met/<br>AUG } start | ACU }<br>ACC } thr<br>ACA }<br>ACG } | AAU } asn<br>AAC }<br>AAA } lys<br>AAG }  | AGU } ser<br>AGC }<br>AGA } arg<br>AGG }      | U<br>C<br>A<br>G |
|            | G | GUU }<br>GUC } val<br>GUA }<br>GUG }            | GCU }<br>GCC } ala<br>GCA }<br>GCG } | GAU } asp<br>GAC }<br>GAA } glu<br>GAG }  | GGU }<br>GGC } gly<br>GGA }<br>GGG }          | U<br>C<br>A<br>G |

Use this table to determine the amino acid order of the first part of the CD28 gene shown above.

1 mark

---



---

- c. The tenth nucleotide in the template strand underwent a substitution mutation where thymine replaced the original nucleotide.

Discuss the effect this may have on the tertiary structure of the polypeptide produced.

2 marks

---

---

---

---

- d. Prior to the expression of the CD28 gene, a repressor protein needs to detach from the operator portion of the gene.

Discuss how the CD28 gene could be expressed. Use the following terms in your response. 2 marks.

transcription factor RNA polymerase promotor repressor molecule regulatory gene

---

---

---

---

- e. Changes in the CD28 gene can lead to diseases such as chronic lymphocytic leukaemia. Six volunteer patients were used for clinical trials of a drug called TGN1412 during 2006. Most of the patients developed multiple system failure, which led to the trial being stopped and the drug trials discontinued.

State **three** problems with the scientific procedure of the clinical trials undertaken.

3 marks

---

---

---

---

---

---

---

---

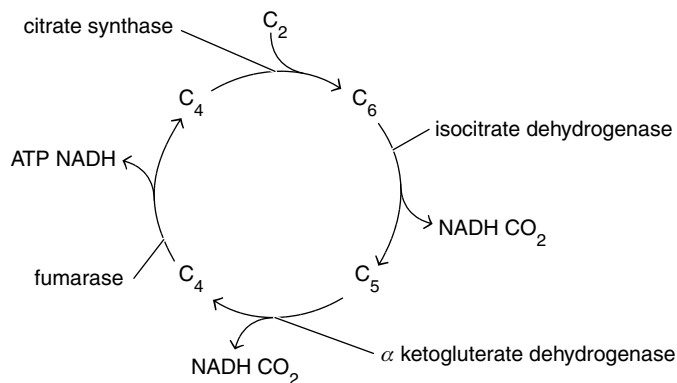
---

---

**Question 3** (9 marks)

A simplified version of a stage of cellular respiration that occurs in the matrix of the mitochondria is shown in the diagram below.

Note:  $C_2$ ,  $C_4$ ,  $C_5$  and  $C_6$  are different sized carbon molecules ( $C_2$  represents two carbon atoms in the molecule,  $C_4$  represents four carbon atoms and so on).



- a. i.** Name the stage of cellular respiration illustrated in the diagram. 1 mark

---

- ii.** State the outputs from the simplified diagram of this stage of cellular respiration. 1 mark

---

- b.** Describe the function of citrate synthase. 2 marks

---



---



---



---

- c.** Fumarase deficiency is a very rare genetic disorder that causes individuals with the condition to have extremely low levels of fumarase.

Use the information provided with the simplified version of cellular respiration to describe **two** effects of fumarase deficiency.

2 marks

---



---



---



---

- d.** The symptoms of fumarase deficiency are extreme and there is no cure for the disease. Why would there be very little research being completed in the development of better therapies for rare diseases such as fumarase deficiency.

2 marks

---

---

---

---

- e.** Is it possible for some plants to also be fumarase deficient? Explain your answer.

1 mark

---

---

**Question 4** (6 marks)

Nitrous oxide ( $\text{N}_2\text{O}$ ) is a gas that behaves as a signalling molecule and is often used to reduce pain. Once inhaled, it moves quickly into cells and binds to intracellular receptors, leading to a reduction in pain.

- a. i.** Discuss the general nature of signal transduction. 1 mark

---

---

- ii.** Discuss the chemical nature of nitrous oxide. 1 mark

---

---

- b.**  $\text{N}_2\text{O}$  inhibits NMDA receptors (excitation response) in the brain whilst simultaneously encouraging the stimulation of the GABA receptors (relaxation response). This eventually produces an anaesthetic effect. Usually other signalling molecules stimulate these receptors.

In terms of the structure of signalling molecules and receptors, discuss how nitrous oxide in the same cell can produce both an inhibitory and stimulatory effect.

2 marks

---

---

---

---

- c.** NMDA receptors are part of a gated protein channel that, when open, allows calcium ions into the neuron that eventuates in exocytosis of neurotransmitters from the axon terminals.

How is this type of action an excitation response?

2 marks

---

---

---

---

**Question 5** (5 marks)

Melbourne scientists have made a groundbreaking discovery in the fight against cancer, finding a way to reduce the growth of some tumours. Gastrointestinal cancers are among the most common and deadly forms of cancer, affecting more than 15 000 Australians each year. In preclinical trials, research showed a molecule called hematopoietic cell kinase (HCK) had a powerful role in the development of cancer because of its effect on macrophages, which are important cells of the immune system.

- a. i.** What type of biomacromolecule is HCK and where within the cell is it synthesised? 1 mark

---

---

- ii.** Describe a typical role macrophages play with respect to the immune response. 1 mark

---

---

- b.** In the preclinical trials, the more HCK a macrophage manufactures, the more it nurtures cancer cell growth and survival.

What is the relationship between cell reproduction and apoptosis in cancerous areas of the body such as the gastrointestinal tract?

1 mark

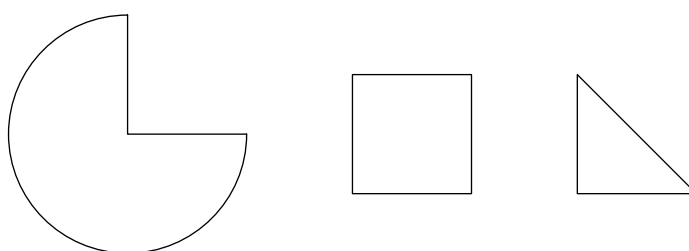
---

---

- c.** A drug has been synthesised that inhibits HCK and reduces the growth of bowel and gastric cancers.

Draw in the space below a labelled diagram illustrating the effect of the drug on HCK if the drug acted as a competitive inhibitor. Use the shapes below to structure your response.

2 marks



**Question 6** (5 marks)

Hashimoto's disease is an autoimmune disease where cells of the thyroid gland are progressively destroyed by the immune system. It is a rare disorder effecting about 1 in every 3000 people worldwide.

- a. i.** Name another autoimmune disease. 1 mark

---

- ii.** Using the words self and non-self, explain how an autoimmune disorder like Hashimoto's disease can appear in an individual. 2 marks

---

---

---

---

- b.** Diagnosis of Hashimoto's disease is confirmed with the presence of antithyroid antibodies in the bloodstream.

Show an understanding of the immune system to explain the presence of antithyroid antibodies in the bloodstream.

2 marks

---

---

---

---

**Question 7** (7 marks)

Insects are ideal organisms to use when quantitatively investigating the mechanisms of evolution. One such insect is the migratory locust (*Locusta migratoria*). *L. migratoria* is a pest to the crop industry, particularly wheat. The breeding pattern of this pest involves a very short life cycle and the production of a large number of offspring.

- a.** How could a short life cycle and the production of a large number of offspring affect the gene pool in a changing environment? 2 marks

---

---

---

---

- b.** In a typical Victorian summer the weather can be very hot, which could be a selective pressure on particular locust phenotypes. Farmers regularly use insecticides to ensure the productivity of their crops is at the highest possible level.

- i.** Describe a particular phenotypic combination that could be at a selective advantage in this hot environment. 1 mark

---

---

- ii.** In a population of 1000 locusts, explain why the number of surviving locusts in a crop that is sprayed with insecticide is lower than one that is not sprayed during a hot summer. 2 marks

---

---

---

---

- c.** Sometimes it is difficult to determine whether different populations of locusts have evolved to a point where they could be classified as different species.

Describe **one** similarity and **one** difference between allopatric speciation and natural selection. 2 marks

---

---

---

---

**Question 8** (10 marks)

There are constantly more pieces of evidence being discovered that shine the spotlight on the accepted view of hominin evolution.

a. Define the term hominin.

1 mark

---

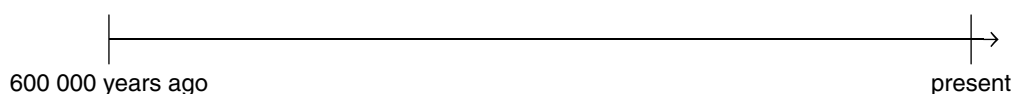
---

b. It was thought that *Homo heidelbergensis* was the common ancestor to *Homo sapiens*, *Homo neanderthalensis* and a recent find called the Denisova hominin. Some key events are listed below.

- *H. heidelbergensis* existed between 700 000 and 200 000 years ago in Africa.
- Climate change forced small groups to migrate out of Africa.
- The first group to leave Africa was the *H. neanderthalensis*, existing between 500 000 and 50 000 years ago.
- When the *H. neanderthalensis* got to the area now known as the Middle East, one group migrated to Europe and eventually died out.
- Another group migrated to southern Asia and evolved into the Denisova hominins between 400 000 and 50 000 years ago.
- *H. sapiens* evolved in Africa and migrated out of Africa about 200 000 years ago, spreading to their current locations.

Construct an evolutionary tree in the space below illustrating the evolutionary path of *H. neanderthalensis*, Denisova hominins and *H. sapiens*. A timeline is provided to give reference.

3 marks



- c. Molecular studies using nuclear and mitochondrial DNA have revealed some extra twists in the tale of human evolution. Non-African *H. sapiens* share up to 4% of their genomes with *H. neanderthalensis*, but none with the Africans.

How could *H. neanderthalensis* and *H. sapiens* share 4% of their genome, and how does this impact on the current classification of the two groups of hominins?

2 marks

---

---

---

---

- d. In addition to the above information, the *H. sapiens* that migrated to southern Asia share up to 6% of their genome with Denisova hominin. However, there have only been two or three bones found that support this evidence.

- i. Discuss why this evidence should be treated seriously by anthropologists.

1 mark

---

---

- ii. Discuss why this evidence should **not** be treated seriously by anthropologists.

1 mark

---

---

- e. How could mtDNA studies be used to determine migration patterns of modern humans from Africa to their current distribution?

2 marks

---

---

---

---

**Question 9** (10 marks)

Gene technology has enabled human insulin to be artificially manufactured within bacteria and then purified for medicinal use by type I diabetics. The steps involved in the procedure from extraction to purification are listed below in the incorrect order.

- Insertion of the modified plasmids into bacteria.
- Amplification of the human insulin gene.
- Isolation of DNA from a human cell.
- Extraction of the insulin protein.
- Selection of the genetically modified bacteria.
- Mixing the restricted plasmid and the restricted human insulin gene together.

- a. Complete the table below by placing the correct step of the insulin purification procedure from the list above in the correct order.

2 marks

|        |                                     |
|--------|-------------------------------------|
| Step 1 | Isolation of DNA from a human cell. |
| Step 2 |                                     |
| Step 3 |                                     |
| Step 4 |                                     |
| Step 5 |                                     |
| Step 6 | Extraction of the insulin protein.  |

- b. Discuss how the restricted plasmid and restricted human gene would successfully anneal together when they are combined.

2 marks

---

---

---

---

- c. Use the following terms to discuss the selection of bacteria that have been genetically modified.

2 marks

bacterial antibiotic resistance gene    restriction enzyme binding site

---

---

---

---

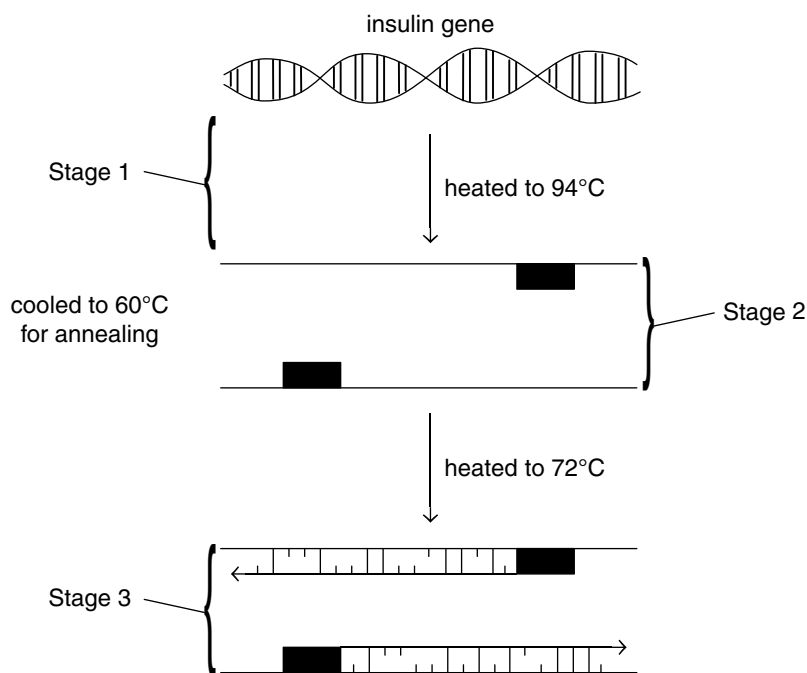
- d. Is the manufacture of genetically engineered insulin by the bacteria an example of a genetically modified organism or an example of a transgenic organism? 1 mark

---

---

---

- e. One of the steps outlined involves the amplification of the human insulin gene. The diagram below represents the amplification process.



Identify the labels for the missing stages in the above diagram and explain their importance for the overall process.

3 marks

Stage 1 \_\_\_\_\_

\_\_\_\_\_

Stage 2 \_\_\_\_\_

\_\_\_\_\_

Stage 3 \_\_\_\_\_

\_\_\_\_\_

**Question 10** (9 marks)

Influenza results in tens of thousands of deaths each year. The elderly and very young are particularly vulnerable, as the young are generally immunologically naive and the elderly are generally immunosuppressed. Therefore, vaccines are not as effective within these population groups. New influenza strains that are resistant to commonly used antiviral medication has highlighted the need to develop more effective drugs that target various aspects of the influenza virus replication cycle.

Three influenza inhibitor drugs (Zanamivir, Amantadine and Maleimide) were compared for their effectiveness both in the amount of relief as well as the time the drug took to start relieving symptoms. These drugs could prove very beneficial for the global population when no suitable vaccine is available for new influenza strains, which may prevent a worldwide pandemic. Experimental data is illustrated in the following two tables to show the effectiveness of the three trialled drugs, with the first table showing the data compiled for Zanamivir and the second table showing the combined data for all three drugs.

| Dose of Zanamivir (mg) | Amount of relief (%) | Time taken for relief (days) |
|------------------------|----------------------|------------------------------|
| 0                      | 0                    | 10                           |
| 1                      | 10                   | 9.5                          |
| 2                      | 15                   | 9                            |
| 4                      | 20                   | 7                            |
| 6                      | 25                   | 4                            |
| 8                      | 25                   | 4                            |

| Drug name  | Amount of relief (%) | Time taken for relief (days) |
|------------|----------------------|------------------------------|
| Zanamivir  | 25                   | 4                            |
| Amantadine | 25                   | 6                            |
| Maleimide  | 12.5                 | 2                            |

- a. i.** What would be a suitable hypothesis for the experiment conducted to generate the results in the first table? 1 mark
- \_\_\_\_\_
- \_\_\_\_\_
- ii.** What conclusion can be made based on the results from the first table? 1 mark
- \_\_\_\_\_
- \_\_\_\_\_
- iii.** What would be done in an experiment such as this to ensure the results were reliable? 1 mark
- \_\_\_\_\_
- \_\_\_\_\_

- b.** Based on the data from the second table, which drug would you recommend for administration to an unvaccinated individual who had recent contact with a person with influenza? Explain your answer. 2 marks

---

---

---

---

- c.** State and explain **two** controlled variables that would need to be taken into account when conducting an experiment such as the one that generated the data in the second table. 2 marks

---

---

---

---

- d.** The bird flu is of worldwide concern as its mortality to humans is very high compared to most other strains of influenza. Currently a new strain of bird flu called H7N9 has a 30% mortality rate and the number of humans contracting the disease has increased dramatically in the last year. There is currently no vaccine available for this particular strain.  
How could knowledge of these antiviral drugs be useful now if there was a worldwide pandemic of H7N9 next year? 2 marks

---

---

---

---

**END OF QUESTION AND ANSWER BOOKLET**