

Student name

# BIOLOGY

## Units 3 & 4

### Trial Examination

#### QUESTION AND ANSWER BOOK

Total writing time: 2 hours 30 minutes

#### Structure of book

| Section      | Number of questions | Number of marks |
|--------------|---------------------|-----------------|
| A            | 40                  | 40              |
| B            | 11                  | 80              |
| <b>Total</b> |                     | <b>120</b>      |

- 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 white out liquid/tape.
- No calculator is allowed in this examination.

#### Materials supplied

- Question and answer book of 33 pages, with a detachable answer sheet for multiple-choice questions inside the front cover.

#### Instructions

- Detach the answer sheet for multiple-choice questions during reading time.
- Write your **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 book are **not** drawn to scale.
- All written responses should be in English.

#### At the end of the examination

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

# STAV Publishing

2018

## BIOLOGY

### Units 3 & 4 Trial Examination

## MULTIPLE CHOICE ANSWER SHEET

|                  |  |
|------------------|--|
| STUDENT<br>NAME: |  |
|------------------|--|

#### INSTRUCTIONS:

#### USE PENCIL ONLY

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **DO NOT** cross it out.
- Marks will **NOT** be deducted for incorrect answers.
- **NO MARK** will be given if more than **ONE** answer is completed for any question.
- Mark your answer by **SHADING** the letter of your choice.

|    | ONE ANSWER PER LINE                                                                                         |    | ONE ANSWER PER LINE                                                                                         |    | ONE ANSWER PER LINE                                                                                         |
|----|-------------------------------------------------------------------------------------------------------------|----|-------------------------------------------------------------------------------------------------------------|----|-------------------------------------------------------------------------------------------------------------|
| 1  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 15 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 28 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 2  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 16 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 29 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 3  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 17 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 30 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 4  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 18 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 31 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 5  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 19 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 32 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 6  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 20 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 33 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 7  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 21 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 34 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 8  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 22 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 35 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 9  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 23 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 36 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 10 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 24 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 37 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 11 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 25 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 38 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 12 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 26 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 39 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 13 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 27 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 40 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 14 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |    |                                                                                                             |    |                                                                                                             |

## SECTION A – Multiple Choice Questions

### Specific instructions for Section A

This section consists of 40 questions. You should attempt **all** questions.

Each question has four possible correct answers. Only **one** answer for each question is correct. Select the answer that you believe is correct and indicate your choice on the Multiple Choice Answer Sheet by shading the letter that corresponds with your choice of the correct answer.

If you wish to change an answer, erase it and shade your new choice of letter.

Each question is worth **one** mark. **No** mark will be given if more than one answer is completed for any question. Marks will **not** be deducted for incorrect answers.

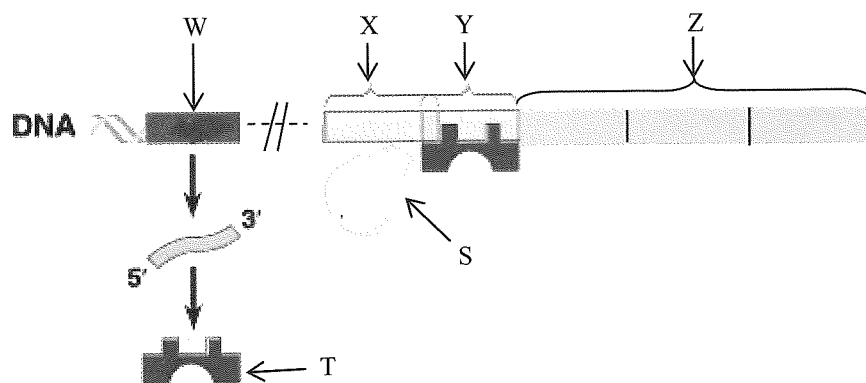
### Question 1

The specific 3-dimensional structure of a protein ultimately depends on the:

- A. peptide bonds between the amino acids.
- B. folding of the polypeptide chain.
- C. protein's ability to form an alpha helix or a beta pleated sheet.
- D. primary structure of the protein.

**Questions 2 and 3 refer to the following information:**

The diagram below shows the *lac* operon found in bacteria.



### Question 2

It can be stated that:

- A. W is the regulator gene, S is RNA polymerase and X, Y and Z are structural genes.
- B. W is the regulator gene, X is the promoter gene, Y is the operator gene and Z are structural genes.
- C. W is the RNA polymerase gene, T is the repressor molecule, and X, Y and Z are structural genes.
- D. W is the repressor gene, T is the repressor molecule and X, Y and Z are structural genes.

### Question 3

When lactose is present in the medium:

- A. S cannot transcribe the structural genes Z.
- B. molecule T will build up in the cell.
- C. it will bind to molecule T that is attached to the gene Y.
- D. the molecule T cannot bind to gene Y and transcription of the structural genes will not occur.

**Question 4**

A scientist transcribed a section of primary mRNA from a section of DNA. She separated the two strands of DNA and analysed their base sequences along with the base sequence of the mRNA. The results are tabulated below.

| nucleic acid: approximate % |      |      |      |      |      |
|-----------------------------|------|------|------|------|------|
|                             | A    | G    | C    | T    | U    |
| <b>DNA strand 1</b>         | 18.6 | 31.7 | 24.4 | 25.3 | 0    |
| <b>DNA strand 2</b>         | 25.2 | 24.6 | 31.5 | 18.7 | 0    |
| <b>mRNA</b>                 | 18.5 | 31.8 | 24.4 | 0    | 25.3 |

The DNA strand that was the template strand for the formation of the section of mRNA would be:

- A. DNA strand 2.
- B. neither strand 1 or strand 2.
- C. DNA strand 1.
- D. some of strand 1 and some of strand 2.

**Question 5**

Transcription in:

- A. eukaryotic cells differs from that in prokaryotic cells as eukaryotic cells do not have promoters like prokaryotic cells.
- B. eukaryotic cells require transcription factors to bind to a promoter region whereas prokaryotic cells do not.
- C. both eukaryotic and prokaryotic cells occurs in the cytosol of the cell.
- D. both eukaryotic and prokaryotic cells involves modification of the transcribed RNA.

**Question 6**

mRNA undergoes modification after transcription. This modification:

- A. includes the addition of introns to the 3' end.
- B. includes the addition of a poly A tail to the 5' end.
- C. includes the addition of a methylated cap structure to the 5' end.
- D. is controlled by the enzyme RNA polymerase.

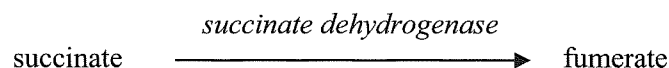
**Question 7**

Co-enzymes are important in enzymatic reactions. Which of the following shows a co-enzyme and its correct function?

- | Co-enzyme           | Function                                                                      |
|---------------------|-------------------------------------------------------------------------------|
| A. NAD              | is involved with enzymes that catalyse reactions that reduce the substrate.   |
| B. ADP              | is needed by enzymes that are involved in endergonic reactions.               |
| C. NAD <sup>+</sup> | transfers high energy electrons to the electron transport chain.              |
| D. NADPH            | transfers high energy electrons and H ions to the light independent reaction. |

**Questions 8 and 9 refer to the following information.**

Succinate dehydrogenase is an enzyme found in the mitochondria of eukaryotic cells. Succinate dehydrogenase is involved in both the Krebs's cycle and the electron transport chain. This enzyme catalyses the following reaction:



When malonate is added to this reaction the rate of the reaction is reduced. If more succinate is added the reaction rate increases again.

### Question 8

As succinate dehydrogenase is involved in both the Krebs's cycle and the electron transport chain it will therefore be found in the:

- A. cytosol of the cell.
- B. inner membrane of the mitochondria.
- C. outer membrane of the mitochondria.
- D. intermembrane space of the mitochondria.

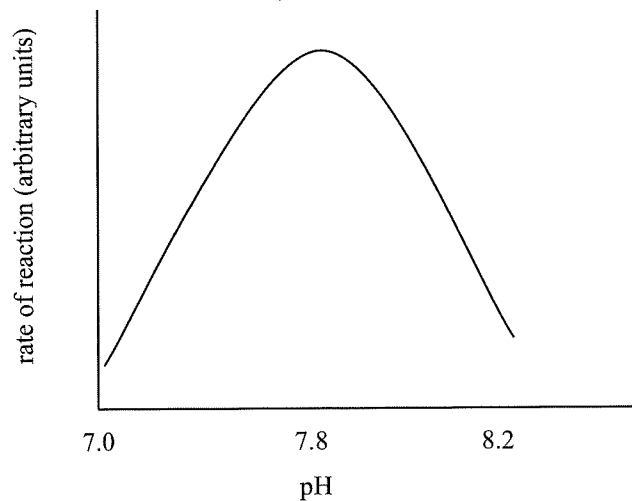
### Question 9

The action of malonate is to:

- A. increase the activation energy of the enzyme succinate dehydrogenase.
- B. act as a non-competitive inhibitor of the enzyme succinate dehydrogenase.
- C. destroy the enzyme succinate dehydrogenase.
- D. act as a competitive inhibitor of the enzyme succinate dehydrogenase.

**Questions 10 and 11 refer to the following information.**

A student investigated the action of an enzyme over a pH range using different buffer solutions and a pH probe. The graph below shows her results.



**Question 10**

The best explanation for the shape of this graph is that:

- A. a pH of 7.8 lowers the activation energy of the enzyme.
- B. a pH of below 7.0 and above 8.2 affects the primary structure of the enzyme.
- C. the enzyme does not function at a pH above 8.
- D. pH affects the active site of the enzyme.

**Question 11**

She measured the pH of the solutions several times in order to:

- A. increase the precision of the measurements.
- B. reduce any random errors.
- C. reduce any systematic errors.
- D. eliminate human error.

**Question 12**

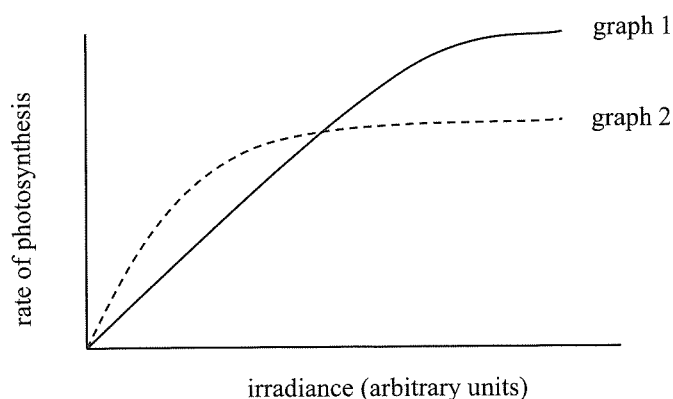
The light-independent reaction of photosynthesis is limited by:

- A. carbon dioxide, temperature and the light-dependent reaction.
- B. water, temperature and carbon dioxide.
- C. oxygen, water and temperature.
- D. water, oxygen and the light-dependent reaction.

**Question 13**

Some plants produce 'sun leaves' in direct sunlight and 'shade leaves' where the leaves are shaded by others. Shade leaves and sun leaves show adaptations to their environments in order to maximise their photosynthetic activity. The table below shows the amount of chlorophyll in sun and shade leaves. The graph below shows the rate of photosynthesis in light.

| leaf type    | total chlorophyll<br>(mg / cm <sup>2</sup> ) |
|--------------|----------------------------------------------|
| shade leaves | 0.028                                        |
| sun leaves   | 0.017                                        |



Using the data above it can be stated that:

- A. graph 2 represents a shade leaf as the rate of photosynthesis is greater in low light than graph 1.
- B. graph 2 represents a sun leaf as it has more chlorophyll increasing the rate of photosynthesis.
- C. graph 1 represents a sun leaf as it has a greater rate of photosynthesis due to more light availability.
- D. graph 1 represents a shade leaf as it takes longer to reach a maximum rate of photosynthesis due to less light availability.

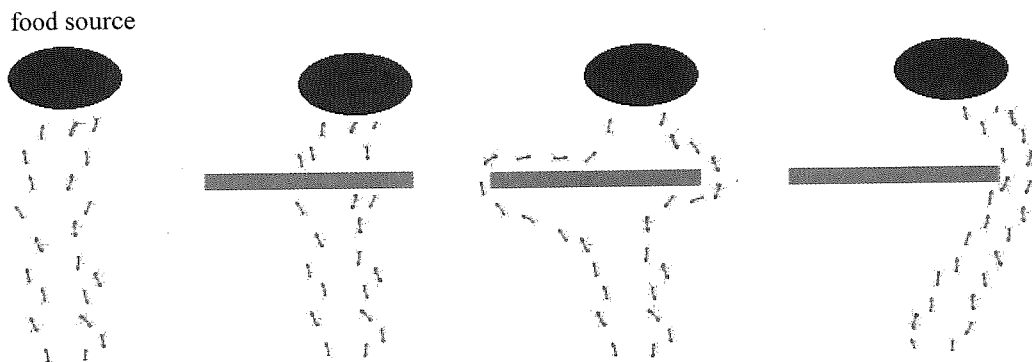
**Question 14**

When the neurotransmitter, acetylcholine, binds to the acetylcholine receptor on the muscle membrane, it causes the muscle to contract. Surgeons use a substance called succinylcholine. When it binds to acetylcholine receptors it causes the muscles to relax which the surgeon can make use of for a surgical procedure. From this information it can be stated that:

- A. both acetylcholine and succinylcholine have different structures so produce different responses in muscle cells.
- B. both acetylcholine and succinylcholine are hydrophobic.
- C. the signal transduction pathway in the muscle cell is amplified by acetylcholine but reduced by succinylcholine.
- D. acetylcholine and succinylcholine have similar structures but trigger different responses when bound to the acetylcholine receptor.

**Question 15**

Ants are observed moving from the nest to a food source. When an object is placed in the path, as shown in the diagram below, the ants find the shortest path to and from the food source.



This movement by the ants is due to:

- A. their sense of direction.
- B. production of trail following pheromones.
- C. trial and error learning.
- D. a follow the leader behaviour.

**Question 16**

Plants need to defend themselves against pathogens. The first line of defence needed to be overcome by a pathogen trying to invade a plant would be:

- A. immune proteins circulating in the phloem of the plant.
- B. antimicrobial chemicals such as phenols.
- C. cells of the plant at the site of invasion undergoing apoptosis in order to prevent the spread of infection.
- D. a physical barrier such as a thick cuticle on the leaves.

**Question 17**

Many people suffer from hay fever in spring as an allergic response to pollen. To relieve the symptoms of a runny nose and eyes these people take anti-allergy medications. Such medications usually contain:

- A. antibodies that bind to the allergen rendering it harmless.
- B. antibiotics to fight the infection caused by pollen entering the nose.
- C. antihistamines to counteract the effect of histamine produced in the allergic response.
- D. complement proteins that bind to the allergen rendering it harmless.

**Question 18**

When a naïve B cell is activated by an antigen it first:

- A. undergoes clonal selection followed by clonal expansion.
- B. becomes a plasma cell that produces antibodies.
- C. migrates to the lymph nodes from the bone marrow to mature.
- D. undergoes clonal expansion followed by clonal selection.

**Question 19**

Type I diabetes results when the insulin producing cells of the pancreas have been destroyed by the body's immune system. It occurs in people with a genetic predisposition. Recent research has suggested that infection with H1N1 influenza (also called swine flu) may put individuals, especially children, at greater risk of developing Type I diabetes. A study in Norway following the 2009 pandemic of swine flu showed that those individuals under 30 years who were reported with influenza were twice as likely to develop Type I diabetes compared to the normal population. Children 15 years and younger had a 25% increase in the chance of developing Type I diabetes. This study suggests that:

- A. 75% of children will not get Type I diabetes.
- B. Type I diabetes is an infectious disease related to influenza.
- C. Type I diabetes, an auto-immune disease, can be triggered by the presence of the influenza virus.
- D. individuals will not get Type I diabetes if they do not suffer from influenza.

**Question 20**

The thymus gland is part of the lymphatic system. Its main function is:

- A. to filter the lymph fluid of bacteria.
- B. the site of maturation of T lymphocytes.
- C. the site of formation and maturation of T lymphocytes.
- D. the site of activation of specific T helper cells.

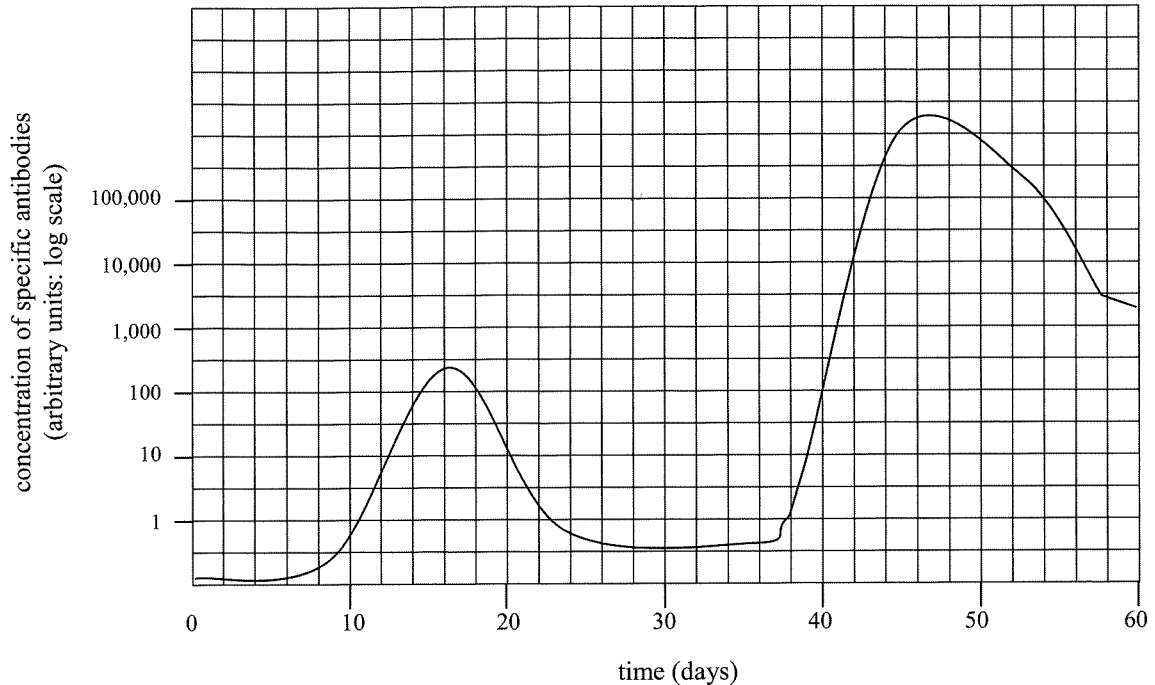
**Question 21**

Vaccines are tested first on susceptible laboratory animals before trials on humans. An example of such animal testing would be to vaccinate:

- A. 100 susceptible mice and expose them to the particular pathogen.
- B. 100 susceptible mice and expose 50 of them to the particular pathogen.
- C. 50 susceptible mice and do not vaccinate another 50 susceptible mice and expose the vaccinated 50 mice to the particular pathogen.
- D. 50 susceptible mice and do not vaccinate another 50 susceptible mice and expose all the mice to the particular pathogen.

**Question 22**

In human trials of a vaccine, fully susceptible individuals were monitored for antibodies against the particular pathogen in their blood. The graph below shows the presence of antibodies against the pathogen over a period of 60 days in a trial participant. The individual was exposed to the pathogen on day 32.



From the graph above, it can be shown that:

- A. the lag time for the response to the pathogen is less for the secondary response than the primary response.
- B. the individual was vaccinated on day 10.
- C. B memory cells are only formed in the secondary response.
- D. the vaccination gives protection for the whole of life.

**Question 23**

Mistakes in chromosome number can occur in individuals. An individual with Turner syndrome has only 45 chromosomes as they have only one X and an individual with Klinefelter syndrome has 47 chromosomes as they have two X chromosomes and a Y. It can be stated that:

- A. both of these are an example of polyploidy.
- B. both of these are an example of aneuploidy.
- C. Klinefelter syndrome is an example of polyploidy and Turner syndrome is an example of aneuploidy.
- D. Klinefelter syndrome is an example of aneuploidy and Turner syndrome is an example of polyploidy.

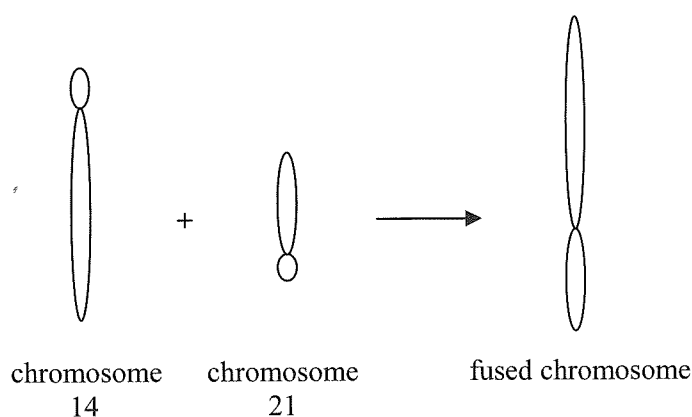
**Question 24**

A frame shift:

- A. occurs if a single base is inserted or deleted in a section of DNA.
- B. occurs if a codon is inserted or deleted in a section of DNA.
- C. occurs if a mutation creates a stop codon in a section of DNA.
- D. results in a missense mutation.

**Question 25**

Sometimes a break occurs in chromosomes and they then rejoin. One example is when the long arms of chromosomes 14 and 21 break and then fuse together with one centromere as shown in the diagram below.



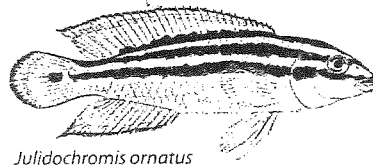
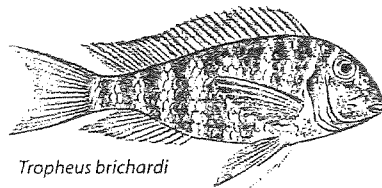
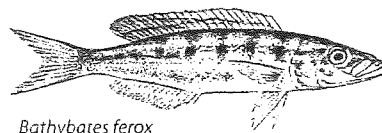
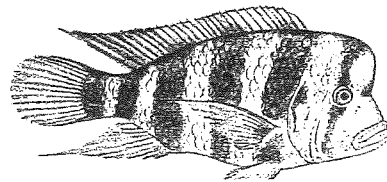
This is an example of a

- A. translocation and the individual would be phenotypically abnormal.
- B. transversion and the individual would be phenotypically abnormal.
- C. block mutation where the individual is phenotypically abnormal.
- D. block mutation where the individual is phenotypically normal.

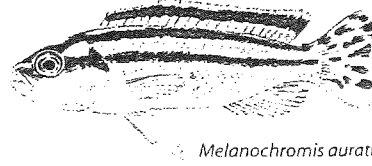
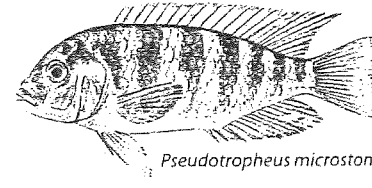
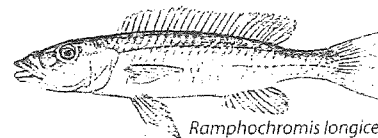
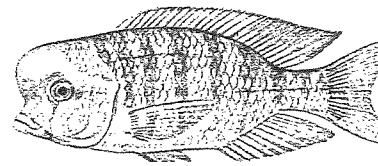
**Questions 26 and 27 refer to the following information.**

In the East African Lakes, Tanganyika, Malawi and Victoria, there exists a diversity of fish known as cichlids. The cichlids in Lake Tanganyika are genetically diverse coming from 11 ancestral species. Some cichlids left Lake Tanganyika and by entering the river system found their way to Lake Victoria and Lake Malawi. Below is a set of diagrams showing some of the different species of cichlids in the two lakes.

LAKE TANGANYIKA SPECIES

*Julidochromis ornatus**Tropheus brichardi**Bathybates ferox*

LAKE MALAWI SPECIES

*Melanochromis auratus**Pseudotropheus microstoma**Ramphochromis longiceps*

Cichlid fishes have evolved highly specialized modes of feeding through extensive adaptations of their jaws over a remarkably short period of time.

### Question 26

The similarity of these pairs of fish from the two different lakes is an example of:

- A. selective breeding.
- B. convergent evolution.
- C. divergent evolution.
- D. co-evolution.

### Question 27

The extensive adaptations in their jaws that developed over such an unusually short period of time is due to:

- A. different feeding niches being available.
- B. different rates of mutations in structural jaw genes.
- C. the difference in expression of the master gene *bmp4* in embryonic development.
- D. the increase in different regulatory genes whose products bind to the genes for jaw development.

**Question 28**

The founder effect and genetic bottlenecks are events that can affect populations.  
It can be stated that:

- A. both of these events result in an increase in genetic diversity.
- B. both of these events are favoured by natural selection.
- C. in a genetic bottleneck the genes with the best survival advantage are passed on whereas in a founder event the genes passed on are favoured by chance.
- D. both of these events are an example of genetic drift.

**Question 29**

An example of allopatric speciation would be initiated by:

- A. a population of squirrels is divided into two populations by a deep canyon between them.
- B. a group of birds on the edge of a population range occupy a different niche and become a different species.
- C. a species of fish becomes two different species by occupying the same area.
- D. subpopulations of a particular rodent of the same species are isolated except for an overlap in a small area of their range.

**Question 30**

After a catastrophic event, babies can become separated from parents and DNA profiling using short tandem repeats helps to confirm relationships. The following diagram shows possible parents and a child.

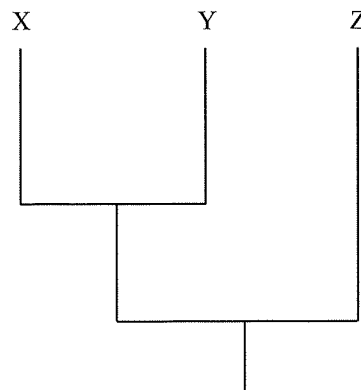
|       | parents 1 |        | parents 2 |        | parents 3 |        | parents 4 |        |
|-------|-----------|--------|-----------|--------|-----------|--------|-----------|--------|
| child | mother    | father | mother    | father | mother    | father | mother    | father |
| ████  | ████      |        |           | ████   |           | ████   | ████      | ████   |
|       |           |        | ████      |        |           |        | ████      |        |
| —     | —         | —      | —         |        | —         |        |           | —      |
| ██    |           | ██     |           | ██     | ██        |        |           |        |
| —     |           | —      |           |        | —         |        |           |        |
| ==    | ==        |        | —         |        | —         |        |           | —      |
| ██    |           |        |           | ██     |           | ██     |           |        |
| —     |           |        |           |        |           | ██     |           |        |
| ██    |           |        |           |        |           | ██     | —         |        |
| —     |           | —      |           |        | —         |        |           |        |

From the diagram the parents of this child would most likely be:

- A. parents 1
- B. parents 2
- C. parents 3
- D. parents 4

**Question 31**

The diagram below represents a phylogenetic tree.

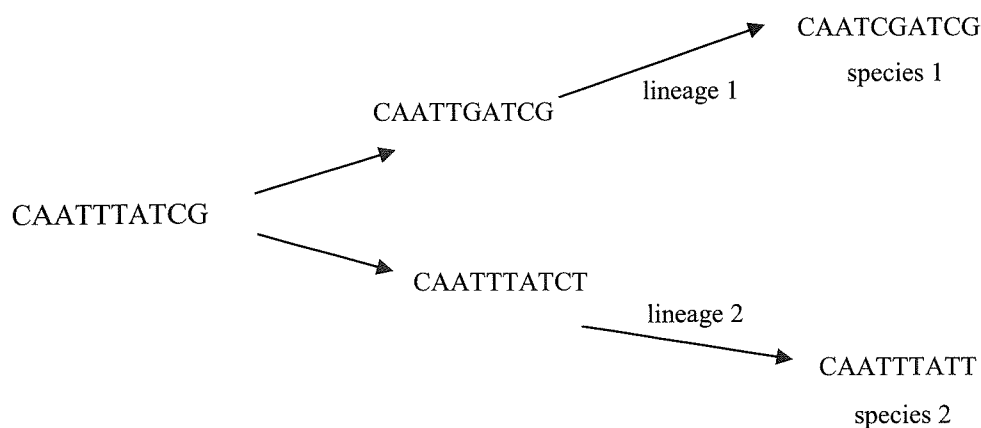


A phylogenetic tree:

- A. indicates when a species evolved.
- B. represents an hypothesis about evolutionary relationships and can change based on new evidence.
- C. has branch lengths that correspond to how long a species has been alive.
- D. shows how much genetic change occurred in a lineage.

**Question 32**

The following diagram shows how a section of DNA from a gene found in two species has undergone mutations. The DNA has changed from a common ancestor at the rate of 1 nucleotide per 25 million years.

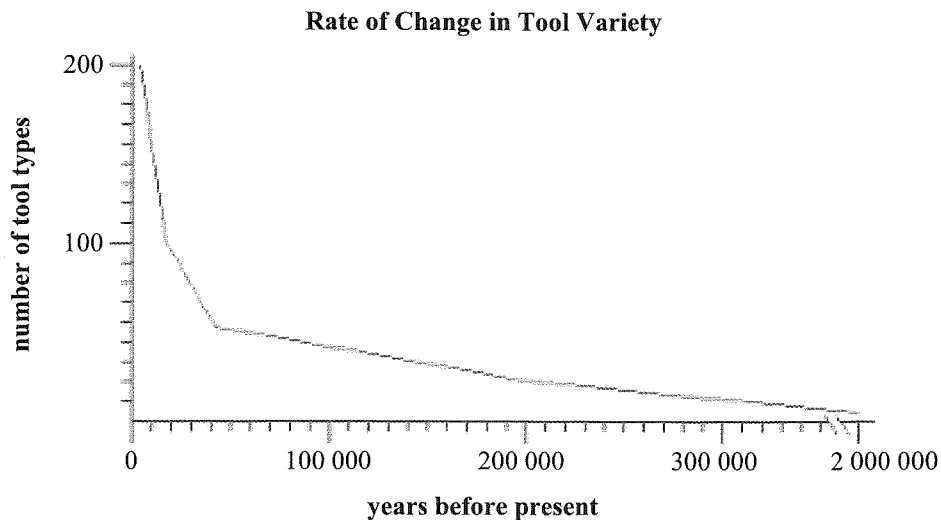


From this data it can be stated that:

- A. species 1 and species 2 had a common ancestor 50 million years ago.
- B. species 1 and species 2 are 50 million years old.
- C. all DNA has a mutation rate of one base per 25 million years.
- D. there are periods of very few mutations followed by periods of many mutations.

**Question 33**

The graph below shows the development of tools and their variety over time. The development of complex tools is related to increased brain development.



From the graph, it can be stated that:

- A. the development of complex tools is slow as it relies on biological evolution.
- B. the rapid development of complex tools most recently could be explained by the development of language.
- C. tool use is found only among members of the species *Homo sapiens*.
- D. the rapid development of complex tools only occurred with the biological development of the human hand.

**Question 34**

When hominin fossil skeletons or parts thereof are found, scientists need to make careful observations to determine if they are of the genus *Homo* or of the genus *Australopithicus*. Knowledge they would apply would be:

- A. only the genus *Homo* walked erect.
- B. the feet of genus *Homo* are smaller with shorter toes.
- C. both the genus *Homo* and the genus *Australopithicus* have an s-shaped spine.
- D. *Australopithicus* has longer limbs than the genus *Homo*.

**Question 35**

Radioactive atoms are unstable over time. The 'parent atoms' decay into more stable 'daughter atoms'. Scientists use this fact to determine the absolute age of fossils, called radiometric dating. The most accurate measurements that need to be made to determine the age of a fossil is to measure the:

- A. increase in the amount of daughter atoms.
- B. decrease in the amount of the parent atoms.
- C. decrease in the amount of the daughter atoms.
- D. ratio of parent atoms to daughter atoms.

**Question 36**

It is true to say that mass extinctions:

- A. occur at regular intervals.
- B. slow down the rate of evolution.
- C. are the widespread loss of biodiversity over a relatively short period of time.
- D. are due to poor adaptations of species to gradual changes in their environment.

**Question 37**

The eye of the octopus and the eye of humans are very similar in structure and yet they are not closely related. This is because:

- A. they must have shared similar selection pressures.
- B. they must have had similar environments.
- C. the gene for eye structure is similar in both.
- D. the eyes in the octopus and humans are homologous structures.

***Questions 38 and 39 refer to the following information.***

When apples are cut or damaged they become brown due to an enzymatic reaction involving the enzyme polyphenol oxidase (PPO). Scientists have developed an apple that does not brown by silencing genes involved in PPO production. They have used a genetic technique called RNA interference (RNAi). RNAi is a natural process that cells use to silence the activity of a gene. The scientists introduced the appropriate RNAi into the plant using genetic engineering. The RNAi binds to the mRNA formed from the PPO gene. This silences the PPO expression to only 10%. This prevents the browning of the apple.

**Question 38**

This new apple is:

- A. a transgenic organism.
- B. both a genetically modified organism and a transgenic one.
- C. both a genetically engineered organism and a transgenic one.
- D. a genetically modified organism but not a transgenic one.

**Question 39**

In using this technique:

- A. the RNAi needs to have a nucleotide sequence complementary to the DNA sequence that codes for the PPO enzyme.
- B. introduction of RNAi would prevent transcription of the gene.
- C. the RNAi needs to have a nucleotide sequence complementary to the mRNA sequence that would be translated into the PPO enzyme.
- D. RNAi replaces the mRNA so no PPO enzyme can be formed.

**Question 40**

Relenza is an antiviral drug that was developed using rational drug design.

It can be stated that Relenza:

- A. is effective against all viruses as all viruses have the same means of entering and leaving the host cell.
- B. disrupts the protein molecule haemagglutinin thus preventing the virus from entering the host cell.
- C. prevents the assembly of new virus particles using the host cell's machinery.
- D. blocks the active site of the enzyme neuraminidase so new virus particles are trapped at the cell surface.

**END OF SECTION A**

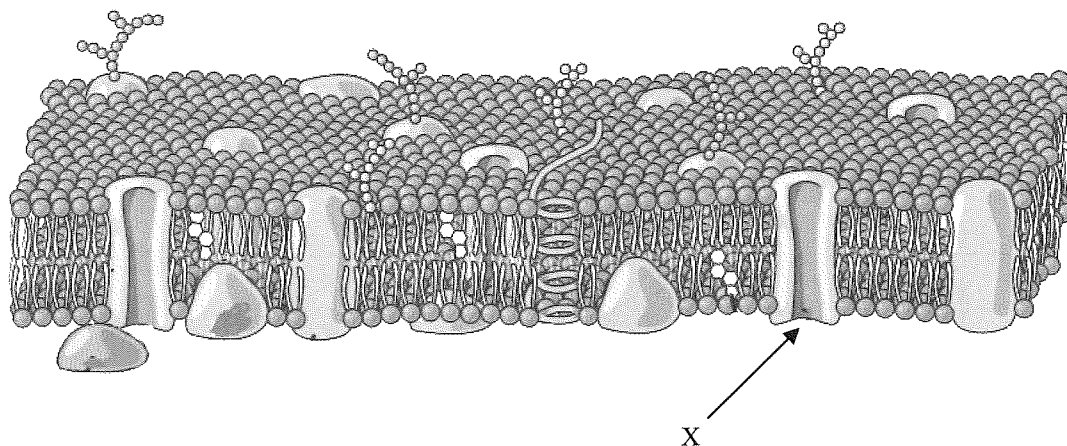
**SECTION B - Short Answer Questions****Specific instructions for Section B**

This section consists of 11 questions. There are 80 marks in total for this section.

Write your responses in the spaces provided. You should attempt **all** questions. Please write your responses in **blue** or **black ink**.

**Question 1**

The diagram below shows a section of the plasma membrane.



- a** Explain how the phospholipid molecules form a bilayer.

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(2 marks)

- b** Name the structure labelled X.

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(1 mark)

- c** What is the function of X?

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(1 mark)

- d** Explain how the general structure **as well as** the internal **and** external structure of X enables it to perform this function.

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(3 marks)

Molecule X was synthesised in the cell and transported to the plasma membrane.

- e** Describe where in the cell molecule X is formed **and** how it is transported to the plasma membrane.

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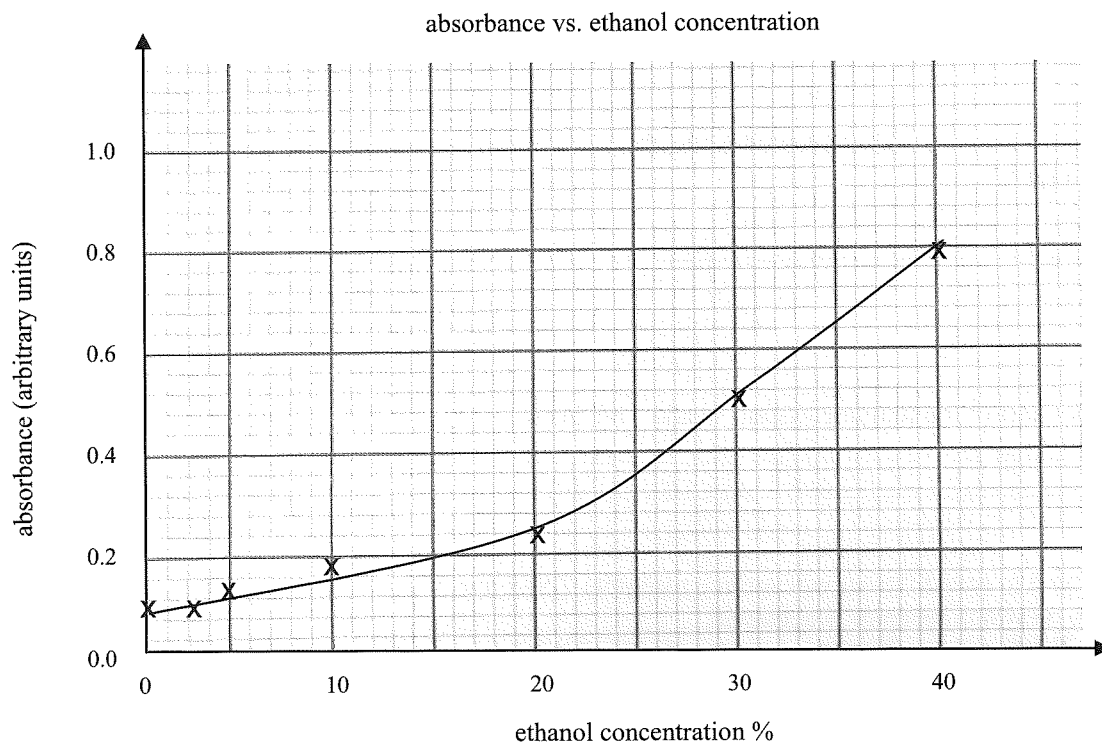
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(2 marks)

Students carried out an experiment to investigate the effect of ethanol on beetroot cell membranes. They placed 2cm length cores of beetroot in different concentrations of ethanol. They measured the permeability using a colorimeter to measure the absorbance at different ethanol concentrations using 450 nm with a blue filter. The greater the absorbance the more the red pigment had leaked out of the beetroot cells. Their results are shown in the graph below.



- f Describe the trend in the results by referring to the graph above **and** what it indicates.

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(1 mark)

- g Variables need to be controlled in this experiment. Circle a controlled variable from the list below.

ethanol concentration

temperature

absorbance

(1 mark)

- h Explain how the variable you have chosen above would affect the results if it **was not** kept constant.

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(2 marks)

**Total 13 marks**

**Question 2**

Tumour necrosis factor (TNF) is a naturally occurring protein secreted by cells of the immune system, especially macrophages. This molecule regulates the production of several pro-inflammatory molecules.

- a** Name the group of molecules that TNF belongs to.

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(1 mark)

- b** What is the role of the group of molecules named in **a** in protecting the individual against pathogens?

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(1 mark)

- c** What part of the immune system would TNF belong to?

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(1 mark)

TNF can bind to two different cell surface receptors TNF1 and TNF2. The result is a different outcome depending on which receptor is activated.

- d** Why does TNF bind to a cell surface membrane rather than entering the cell?

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(1 mark)

- e** How does the binding of a molecule such as TNF to different receptors result in different outcomes?

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(1 mark)

When TNF binds to the THF1 receptor on the cell surface, it sets off a series of reactions resulting in the formation of caspases.

- f** What process in the cell will result after the production of caspases triggered by an external signal?

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(1 mark)

Rheumatoid arthritis (RA) is an autoimmune disease that affects the joints. Individuals with RA have higher levels of TNF. Pharmaceutical companies have developed monoclonal antibodies against TNF.

**g** What are monoclonal antibodies?

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(1 mark)

**h** What effect are doctors trying to achieve by the use of these monoclonal antibodies in patients with RA?

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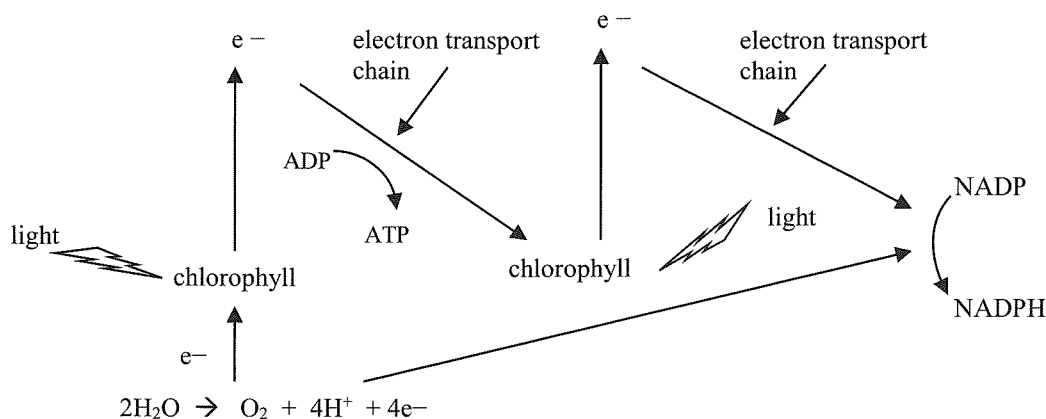
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(2 marks)

**Total 9 marks**

**Question 3**

Photosynthesis consists of a light-dependent reaction and a light-independent reaction. The result is the formation of carbohydrates and oxygen. The following diagram is a summary of the light-dependent reaction of photosynthesis.



- a** Suggest how the structure of the chloroplast is an adaptation to its role in the light-dependent reaction of photosynthesis.

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(1 mark)

The products of the light-dependent reaction are NADPH and ATP.

- b** What is the function of each of these molecules in the reaction of photosynthesis?

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(2 marks)

Some weed killers act by blocking the electron transport chains in photosynthesis.

- c** Explain, by referring to the diagram above, the consequence for the weed when weed killer is applied to it.

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(2 marks)  
**Total 5 marks**

Human papillomavirus (HPV) has been associated as a risk factor in developing cervical cancer. The virus is transmitted by sexual intercourse. A vaccine called Gardasil was developed in Australia by Professor Ian Fraser. Vaccination against HPV forms part of the National Vaccination programme and is given to both girls and boys at 12-13 years of age.

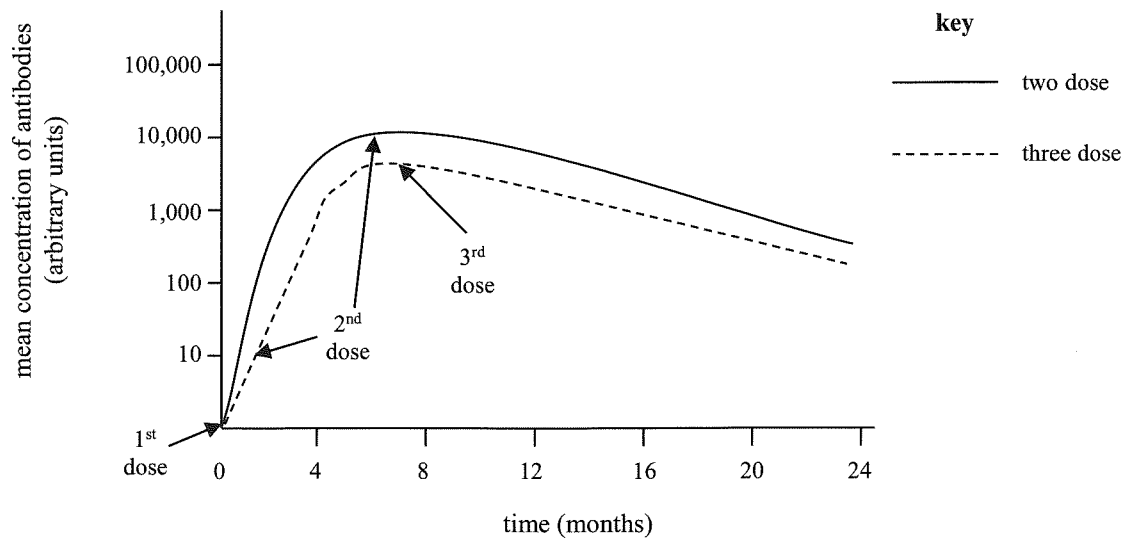
- (1 mark)

- b** Outline the steps in the development of antibodies and long-term immunity as a result of the administration of this vaccine.

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(4 marks)

An international study into how a two dose vaccination programme compared with the traditional three dose programme showed the following results for 9 to 15 year olds.



- c Why have some countries (including Australia in 2018) decided to adopt a two dose regime rather than the three dose regime for 9 to 15 year olds based on the above data?

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(1 mark)

- d Using your knowledge of the immune system, why is it recommended that the two doses be given at least 6 months apart?

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(1 mark)

**Total 7 marks**

**Question 5**

Huntington disease (HD) is a late onset, incurable neurological disorder that is inherited as an autosomal dominant condition. There is a predictive genetic test for this condition available. A woman who is 10 weeks pregnant to a man whose father died of HD, wishes for her foetus to be tested. Her partner does not want to know his HD status.

- a** What is a predictive genetic test?

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(1 mark)

- b** State **three** ethical implications that arise from this scenario.

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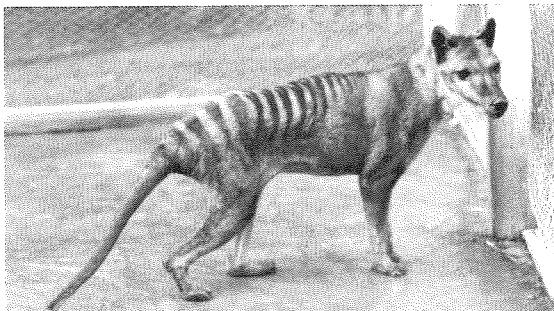
(3 marks)

**Total 4 marks**

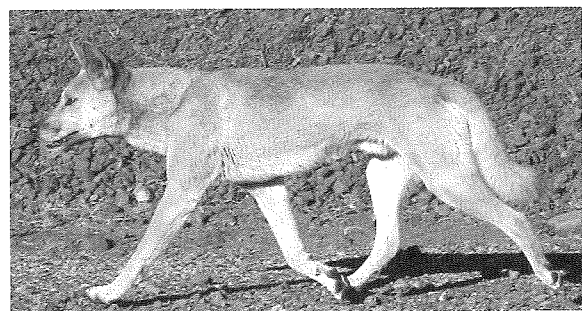
**Question 6**

The thylacine or Tasmanian tiger was the largest marsupial predator that survived into recent times. The last thylacine died in captivity in 1936.

The thylacine and the dingo (shown below) shared a common ancestor more than 150 million years ago and yet they are very similar in body shape.



thylacine



dingo

- a** What type of evolution is this an example of?

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(1 mark)

*Read the following extract to answer parts b, c and d.*

### **Marsupial extinctions: don't blame the dingoes**

The humble dingo has become something of a scapegoat since its arrival in Australia just 4000 years ago. It is widely blamed for the disappearance of thylacines (also known as Tasmanian tigers) and devils from the mainland - an event that left Tasmania as their sole refuge.

The hypothesis is that when dingoes spread through the mainland, they were smarter, faster and more versatile predators than their marsupial counterparts, who lost the battle for survival.

But our analysis might yet earn the dingo a reprieve. We have found evidence that - as with earlier Australian extinction events - humans are the more likely culprits.

Sometime within the last few thousand years, both the thylacine and the Tasmanian devil disappeared from mainland Australia, to hang on only in Tasmania

### **Enter the dingo**

Dingoes are descended from Asian wolves and were presumably widely transported as semi-domestic animals by seafaring people colonising the Pacific. They made landfall in northern Australia some 4000 years ago and quickly spread to all corners of the continent – but not Tasmania.

The rough coincidence of the dingo's arrival with the extinction of the two largest marsupial carnivores suggests the natives were undone by a superior competitor. Maybe the dingo was a better hunter; perhaps it was also more aggressive and killed them off. The fact that thylacines and devils survived on the only large chunk of Australia (*Tasmania*) not reached by the dingo is pretty strong circumstantial evidence for this idea.

But there is another possibility. Evidence has been slowly building that Australia's human population dramatically changed its behaviour during the past 4,000 years.

Hunting and gathering strategies became more elaborate and probably more efficient, and people became less nomadic. As a result, the population grew, possibly increasing more than threefold between 2000 BC and European arrival.

Our study (also highlighted in the journal *Science*), took a new approach. We created a mathematical model of the interactions among predators (people, dingoes, thylacines and devils) and prey (represented by kangaroos) in prehistoric Australia. We also factored in the effects of variable rainfall on vegetation, and knock-on effects on animals. Then we experimented with the model to test which factors had the largest impacts on abundance of thylacine and devils.

The answer was surprisingly clear. The most influential factor in the decline of the marsupial carnivores was human population growth.

*Source: extract adapted from C. Johnson (University of Tasmania) B. Brook (University of Adelaide) C. Bradshaw (University of Adelaide) T. Prowse (University of Adelaide)*

Marsupial extinctions: don't blame the dingoes. The Conversation website January 10, 2014

<<https://theconversation.com/au>>

- b** Using the information in the text, give **two** pieces of information that support the hypothesis that dingoes *were* to blame for the disappearance of the thylacine and the devil from the mainland.

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(2 marks)

- c** Give **two** pieces of evidence that the authors used in coming to the conclusion that dingoes *were not* to blame for the disappearance of the thylacine and the devil from the mainland.

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(2 marks)

- d** Justify how the evidence supports the hypothesis of the authors that the dingo was not the most influential factor in the disappearance of the thylacine and the devil from the mainland.

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(2 marks)

**Total 7 marks**

**Question 7**

Artificial selection or selective breeding has been an important tool in the agricultural industry.

- a** How does the process of artificial selection differ from natural selection?

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(1 mark)

Artificially selected organisms usually have lower genetic diversity than the wild species from which they have evolved.

- b** Explain this observation.

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(1 mark)

Research has shown that intense artificial selection has resulted in harmful variants increasing in frequency in the populations of many different species of domestic animals and plants. One example is dairy cows of different breeds that have been artificially selected for high milk yield, also having lower than normal fertility.

- c** Suggest **two** ways that these harmful alleles could become more frequent in the populations of artificially selected species.

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(2 marks)

**Total 4 marks**

**Question 8**

Hominins first evolved around 5 million years ago.

- a** Besides the genus *Homo*, name another two genera that make up the hominin family tree.

(2 marks)

In January 2018, scientists published a paper describing an upper jaw with intact teeth that had been discovered in a cave in Israel. This fossil was dated as existing between 177 000 and 194 000 years ago. This made it the oldest fossil of *Homo sapiens* to be discovered outside of Africa.

- b** What does the finding of this fossil in Israel possibly suggest about the movement of *Homo sapiens*?

(1 mark)

Scientists examined the teeth of this fossil and found that they were large but did fall within the range for *Homo sapiens*.

- c** Besides tooth structure, give **one** feature of a skeleton which would indicate that the individual could be a modern *Homo sapiens* and not another *Homo* species.

(1 mark)

Some scientists, however, still have doubts about classifying this fossil as *Homo sapiens*.

- d** Suggest why there would be doubts concerning the classification.

(1 mark)

**Total 5 marks**

**Question 9**

A particular bacterial plasmid containing the lacZ gene and an ampicillin resistant gene can be cut by the restriction enzyme EcoR1 at the following recognition site within the lacZ gene. A foreign piece of DNA can then be inserted into the plasmid at that site. EcoR1 cuts at the site shown below to give sticky ends.



- a** Draw the restriction cut on the complementary strand of DNA.

(1 mark)

- b** Explain why the foreign piece of DNA to be inserted needs to be cut by the restriction enzyme EcoR1.

(1 mark)

- c** Name the enzyme used to attach the foreign DNA into the plasmid.

(1 mark)

The recombinant plasmids are mixed with a culture of bacteria and treated so that some bacteria will take up the recombinant plasmids. Some bacteria may also take up plasmids that do not contain the foreign gene.  $\beta$  galactosidase is the product of the lacZ gene. Xgal is a molecule, that when present in the media, can be broken down by the enzyme  $\beta$  galactosidase making the colonies of bacteria blue. If the bacteria cannot produce  $\beta$  galactosidase then the colonies are white.

- d** Explain how scientists use the presence of the ampicillin resistant gene and the presence of Xgal in the media to identify the colonies that have been successfully transformed.

(4 marks)

- e Suggest a use of recombinant bacterial plasmids.

(1 mark)

**Total 8 marks****Question 10**

The gene TAS2R38 has two allelic forms. Those with the T form of the gene, are able to taste the bitter chemical phenylthiocarbamide (PTC) and those with the alternative form of the gene (t) cannot. The two forms of the gene differ by three bases at three different sites (single nucleotide polymorphs) resulting in the possibilities of three different amino acids.

| mRNA Codon Chart |   |               |           |               |            |   |
|------------------|---|---------------|-----------|---------------|------------|---|
|                  |   | Second Base   |           |               |            |   |
|                  |   | U             | C         | A             | G          |   |
| First Base       | U | Phenylalanine | Serine    | Tyrosine      | Cysteine   | U |
|                  |   | Phenylalanine | Serine    | Tyrosine      | Cysteine   | C |
|                  |   | Leucine       | Serine    | Stop          | Stop       | A |
|                  |   | Leucine       | Serine    | Stop          | Tryptophan | G |
|                  | C | Leucine       | Proline   | Histidine     | Arginine   | U |
|                  |   | Leucine       | Proline   | Histidine     | Arginine   | C |
|                  |   | Leucine       | Proline   | Glutamine     | Arginine   | A |
|                  |   | Leucine       | Proline   | Glutamine     | Arginine   | G |
|                  | A | Isoleucine    | Threonine | Asparagine    | Serine     | U |
|                  |   | Isoleucine    | Threonine | Asparagine    | Serine     | C |
|                  |   | Isoleucine    | Threonine | Lysine        | Arginine   | A |
|                  |   | Methionine    | Threonine | Lysine        | Arginine   | G |
|                  | G | Valine        | Alanine   | Aspartic Acid | Glycine    | U |
|                  |   | Valine        | Alanine   | Aspartic Acid | Glycine    | C |
|                  |   | Valine        | Alanine   | Glutamic Acid | Glycine    | A |
|                  |   | Valine        | Alanine   | Glutamic Acid | Glycine    | G |
|                  |   | Third Base    |           |               |            |   |

- a Use the table of codons above to complete the change in amino acids for non-taster to taster in the far right-hand column of the table below.

| Nucleotide position | DNA change |        | Changes in the codon |        | Change in amino acid |        |
|---------------------|------------|--------|----------------------|--------|----------------------|--------|
|                     | non-taster | taster | non-taster           | taster | non-taster           | taster |
| 145                 | G          | → C    | GCA                  | → CCA  | →                    |        |
| 785                 | U          | → C    | GUU                  | → GCU  | →                    |        |
| 886                 | A          | → G    | AUC                  | → GUC  | →                    |        |

(2 marks)

In the lab, students collected samples of cheek cells, extracted the DNA and isolated the TAS2R38 locus. They made billions of copies of a portion of the gene.

- b Name the process used to make these copies.

(1 mark)

- c The procedure in part b uses 'primers'. What are primers **and** what is their function in this procedure?

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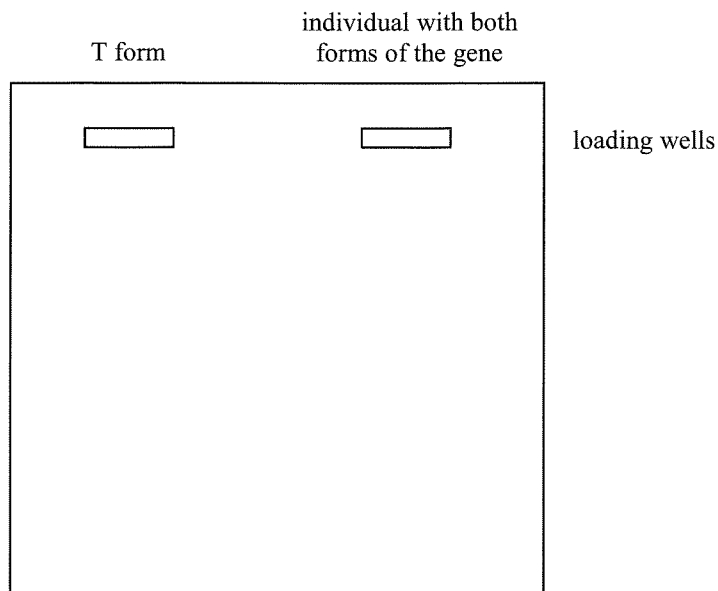
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(2 marks)

Students used a restriction enzyme, HaeIII, that cuts one of the single nucleotide polymorphs in the taster (T) form of the gene but not in the non-taster (t) form of the gene. They then ran the digested DNA from a heterozygous individual on an electrophoresis gel. The T form was also run and is known to give two bands of 177 base pairs and 44 base pairs.

- d Complete the electrophoresis diagram below to show the T form and the individual with both forms by drawing the bands for the T allele and the individual. Label the diagram with the correct polarity and the direction of movement of the fragments through the gel.



(3 marks)

All human populations are made up of tasters and non-tasters of PTC even though PTC is not a naturally occurring molecule.

- e What inference can be made that explains this observation?

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(2 marks)

**Total 10 marks**

**Question 11**

*Serratia marcescens* is a species of bacteria that produces the red pigment prodigiosin. When grown on agar plates the colonies appear a pink colour. Mutations in the bacterial DNA can cause colonies to appear white.

A student plated 5 sterile agar plates with *Serratia marcescens*. The plates were then exposed to UV light for various lengths of time and then incubated in the dark for 48 hours at 25°C. Five un-inoculated sterile plates were also exposed to the UV light first **then** inoculated and similarly incubated. After 48 hours the colonies with altered pigmentation were counted as well as those unaltered as shown in the table below.

|                                           | duration of exposure to UV light in seconds |     |     |     |    |
|-------------------------------------------|---------------------------------------------|-----|-----|-----|----|
|                                           | 0                                           | 5   | 15  | 30  | 60 |
| total no. of colonies                     | 178                                         | 205 | 182 | 165 | 85 |
| no. of colonies with altered pigmentation | 1                                           | 21  | 38  | 47  | 55 |

The plates that were exposed to UV light and then inoculated and incubated all showed unaltered colonies.

- a** Write an hypothesis for this experiment.

\_\_\_\_\_  
\_\_\_\_\_  
(1 mark)

- b** Identify:

i. the dependent variable \_\_\_\_\_

ii. the independent variable \_\_\_\_\_

\_\_\_\_\_  
(2 marks)

- c** Why were the un-inoculated plates exposed to UV light?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
(1 mark)

- d** Why was there a decrease in the total number of colonies with increased exposure to UV light?

\_\_\_\_\_  
\_\_\_\_\_  
(1 mark)

- e What conclusion can the student draw from this investigation? You should refer to each of the following in your answer
- the variables referred to in part **b**
  - the significance of the plates inoculated after exposure.
  - the significance of the unexposed inoculated plate.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper appears to be a standard notebook page.

(3 marks)

**Total 8 marks**

**END OF TRIAL EXAMINATION**

## Acknowledgements

<http://www.namrata.co/lac-operon-regulation-of-gene-expression-in-prokaryotes/lac-operon-off/>

<https://www.linkedin.com/pulse/why-worker-ants-make-better-decisions-than-queen-charles-cohon>

[http://www.cichlid-forum.com/articles/lakes\\_east\\_africa.php](http://www.cichlid-forum.com/articles/lakes_east_africa.php)

[http://www.cienhd-forum.com/articles/snakes\\_east\\_africa.php](http://www.cienhd-forum.com/articles/snakes_east_africa.php)  
<https://www.khanacademy.org/science/biology/membranes-and-transport/the-plasma-membrane/a/structure-of-the-plasma-membrane>