

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

Materials supplied

- Question and answer book of 31 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

2020

BIOLOGY

Units 3 & 4 Trial Examination

MULTIPLE CHOICE ANSWER SHEET

| | |
|--------------------------|--|
| STUDENT 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.

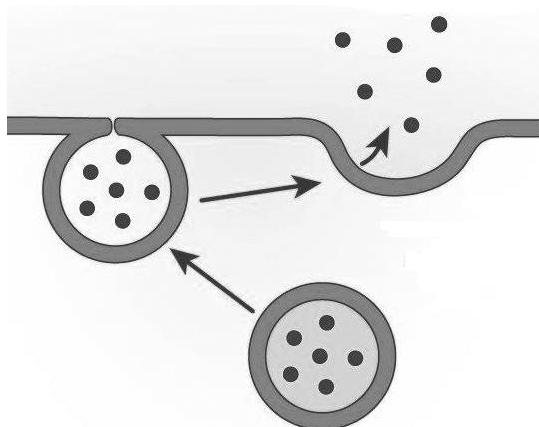
If you wish to change an answer, erase it and shade your new choice of letter.

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.

Questions 1 and 2 refer to the following information and diagram.

Insulin is a hormone produced by the β cells of the pancreas. The diagram below shows the passage of insulin molecules across the cell membrane.

**Question 1**

The process depicted in the diagram above:

- A. does not need energy due to the concentration being less outside the cell initially.
- B. occurs due to transmembrane proteins in the plasma membrane.
- C. is made possible because of the fluidity of the cell membrane.
- D. is possible because of the presence of cholesterol in the plasma membrane.

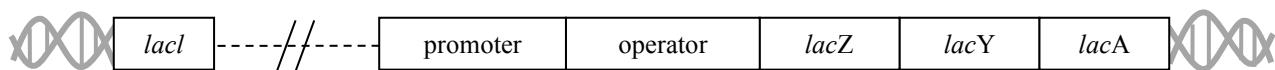
Question 2

Which one of the following shows the organelle associated with the transport of insulin within the cell?

- | organelle | transport of insulin function |
|--------------------------------|--|
| A. rough endoplasmic reticulum | transports insulin within the cell to the Golgi body |
| B. ribosomes | site of formation of insulin from amino acids |
| C. Golgi body | transports insulin to the endoplasmic reticulum for modification |
| D. secretory vesicles | transports insulin to the Golgi body |

Questions 3, 4 and 5 refer to the following information and diagram.

The *lac* operon found in *E.coli* bacteria is shown in the diagram below:



lacZ codes for β galactosidase which catalyses lactose into galactose and glucose

lacY codes for a transmembrane protein enabling lactose to enter the cell

lacA codes for an enzyme, acetyltransferase that is not involved directly in lactose metabolism

Question 3

Using your knowledge and the diagram above, it can be stated that when lactose is present in the medium:

- A. RNA polymerase cannot bind to the promoter.
- B. the transcription factor is not produced by the regulator gene *lacI*.
- C. the repressor protein production is at a maximum.
- D. genes *lacZ*, *lacY* and *lacA* are transcribed producing molecules of mRNA.

Question 4

Using your knowledge and the diagram above, it can be stated that when lactose is present in the medium:

- A. lactose metabolism is increased by lactose binding to the promoter.
- B. the transport of lactose into the cell will increase.
- C. β galactosidase will bind to the repressor protein.
- D. an increasing amount of RNA polymerase will be produced to transcribe genes *lacZ*, *lacY* and *lacA*.

Question 5

If a mutation for *lacI* occurs in an *E. coli* bacterium such that the product of this gene is unable to bind to DNA, it would be expected that such a bacterium would:

- A. not be able to metabolise lactose.
- B. undergo transcription of the structural genes whether lactose is present or not in the media.
- C. be harmed if lactose was present in the media.
- D. not be able to bind RNA polymerase to DNA.

Question 6

A section of a protein that consists of two linear segments of a polypeptide chain that lie next to each other and are held side by side by hydrogen bonds between them is referred to as:

- A. the primary structure
- B. an alpha helix
- C. a beta pleated sheet
- D. the tertiary structure

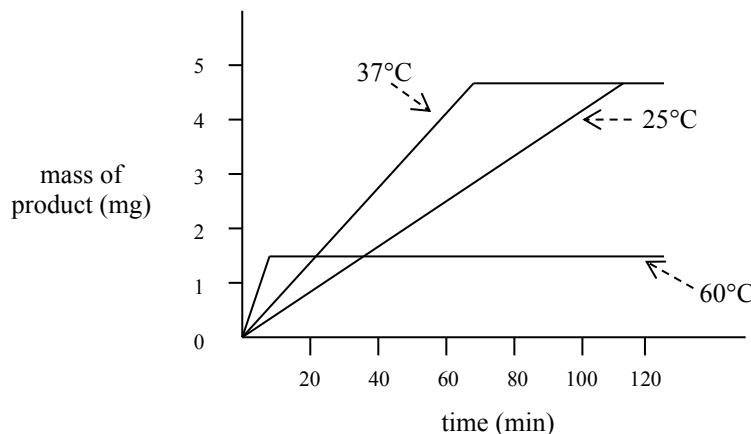
Question 7

Many medications act by targeting proteins in the cell and/or acting within pathways involving interaction with many proteins. Researchers are working to personalise drugs for different individuals in order to achieve better effectiveness. This approach would best rely on advances in:

- A. genetics
- B. immunology
- C. enzymes
- D. proteomics

Questions 8, 9, 10 and 11 refer to the following information and graph.

A student investigated the action of an enzyme at various temperatures. A fixed amount of substrate was added to 3 different test tubes and a fixed amount of enzyme was then added to each. The test tubes were incubated at 3 different temperatures. The results are graphed below:

**Question 8**

A possible hypothesis for this experiment would be:

- A. the enzyme will cease to react after 120 minutes.
- B. this enzyme will only function at 37°C.
- C. the higher the temperature of incubation, the faster the reaction.
- D. the reaction will level out when there is no more enzyme.

Question 9

The dependent variable for this reaction is the:

- A. mass of product formed
- B. rate of formation of product
- C. temperature
- D. time

Question 10

The student, when analysing the results, would have rightly concluded that:

- A. the tube incubated at 60°C had less substrate.
- B. the enzyme would cease to function at a temperature less than 10°C.
- C. the experiment would give less product at 15°C.
- D. the enzyme was denatured at 60°C.

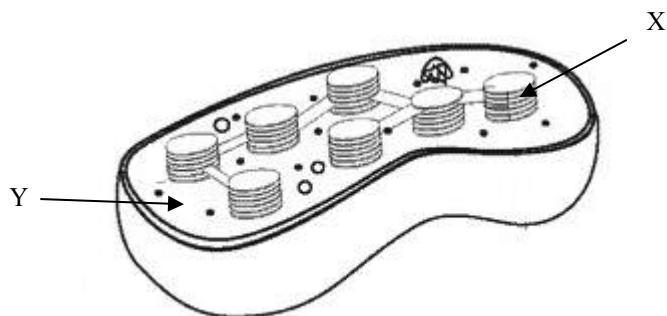
Question 11

The teacher suggested that the student repeat the experiment. This was to ensure that the results:

- A. were accurate
- B. were precise
- C. were reliable
- D. contained no systematic errors

Question 12

The following is a three-dimensional diagram of an organelle found in some eukaryotic cells.



Using the diagram above it can be stated that:

- A. the area labelled Y is where glucose enters glycolysis.
- B. ATP is produced from ADP and P_i in the area labelled Y.
- C. glucose molecules enter the electron transport chain in the area labelled X.
- D. NADPH is produced in the area labelled X.

Question 13

A scientist set up an experiment in order to investigate photosynthesis. Plant 1 was supplied with CO₂ containing radioactive oxygen (¹⁸O) and normal water containing non-radioactive oxygen (¹⁶O). Plant 2 was supplied with CO₂ containing non-radioactive oxygen (¹⁶O) and water containing radioactive oxygen (¹⁸O). Both plants were left to photosynthesise and the products, oxygen and glucose, were tested for the presence of radioactive oxygen.

One would expect radioactive oxygen atoms to be produced as follows:

Plant 1

- A. produces both radioactive oxygen and glucose.
- B. produces radioactive oxygen but not radioactive glucose.
- C. produces radioactive oxygen but not radioactive glucose.
- D. produces radioactive glucose but not radioactive oxygen.

Plant 2

- produces radioactive oxygen but not radioactive glucose.
- produces both radioactive oxygen and glucose.
- produces radioactive glucose but not radioactive oxygen.
- produces radioactive oxygen but not radioactive glucose.

Question 14

A plant is placed in an atmosphere of excess carbon dioxide with an increasing light intensity. The limiting factor for the rate of photosynthesis under these conditions would be:

- A. carbon dioxide concentration
- B. temperature
- C. light intensity
- D. oxygen concentration

Question 15

Glycolysis is considered to be an ancient evolved metabolic pathway because it:

- A. produces less ATP than the electron transport chain.
- B. occurs in membrane bound organelles.
- C. uses 2 ATP and generates 4 ATP.
- D. is present in most organisms from bacteria to eukaryotes.

Question 16

Adrenaline is a hydrophilic signalling molecule. It can therefore be stated that:

- A. the receptor for adrenaline is located in the cytosol of target cells.
- B. adrenaline is likely to trigger a signal transduction pathway in target cells.
- C. attaches to the DNA directly resulting in gene expression in target cells.
- D. molecules of adrenaline are a second messenger.

Question 17

Cells of the immune system that are involved in both cellular immunity and the humoral response are:

- A. plasma cells
- B. cytotoxic T cells
- C. platelets
- D. T helper cells

Question 18

Interferons are a type of cytokine signalling molecule that are produced by cells invaded by viruses. One important result of the production of interferons by these cells would be to:

- A. attract mast cells that would produce histamine.
- B. activate B cells into plasma cells that would produce antibodies against the virus.
- C. attract macrophages to destroy the viral infected cells.
- D. coat the virus particles enabling them to be ingested by macrophages.

Question 19

Rickettsial infections are caused by an unusual type of bacteria that can only live inside the cells of another organism. Some cause diseases such as typhus in humans. Protection by the immune system against these organisms is best provided by:

- A. antibodies that can enter infected cells.
- B. T cells that recognise displayed antigens exhibited by major histocompatibility complex molecules on the cell surface.
- C. inhibition of apoptosis of the infected cells.
- D. the complement system of proteins.

Question 20

An antibody:

- A. cannot be transferred from one human to another.
- B. has variable regions that bind to antigens.
- C. has three binding sites.
- D. is composed of one light and one heavy chain.

Question 21

As a result of clonal selection, a second exposure to the same pathogen results in:

- A. a faster response because the appropriate antibodies are circulating in the bloodstream.
- B. a slower, but more long term response due to B memory cells being activated.
- C. a faster response because B memory cells are able to ingest the pathogens.
- D. a faster response because the appropriate B memory cells are quickly activated.

Question 22 refers to the following information and table.

HFE gene controls the formation of a protein on the cell surface. Mutations in the gene result in the hereditary disease Haemochromatosis, causing the body to store too much iron. Part of the normal peptide and the common mutation are shown below:

| Amino acid number | 280 | 281 | 282 | 283 | 284 |
|-----------------------|----------|-----------|----------|-----------|--------|
| Normal peptide | Tyrosine | Threonine | Cysteine | Glutamine | Valine |
| Peptide with mutation | Tyrosine | Threonine | Tyrosine | Glutamine | Valine |

The Genetic Code for RNA codons to amino acids

Second base letter

| | U | C | A | G | | |
|---|---|--|--|--|---|------------------|
| F i r s t B a s e L e t t e r | U | Phenylalanine Phenylalanine Leucine Leucine | Serine Serine Serine Serine | Tyrosine Tyrosine <i>Stop</i> <i>Stop</i> | Cysteine Cysteine <i>Stop</i> Tryptophan | U C A G |
| | C | Leucine Leucine Leucine Leucine | Proline Proline Proline Proline | Histamine Histamine Glutamine Glutamine | Arginine Arginine Arginine Arginine | U C A G |
| | A | Isoleucine Isoleucine Isoleucine Methionine | Threonine Threonine Threonine Threonine | Asparagine Asparagine Lysine Lysine | Serine Serine Arginine Arginine | U C A G |
| | G | Valine Valine Valine Valine | Alanine Alanine Alanine Alanine | Aspartic acid Aspartic acid Glutamic acid Glutamic acid | Glycine Glycine Glycine Glycine | U C A G |

Question 22

It can be stated that the simplest change in the DNA triplet of the template strand resulting in this mutation would be:

- A. C to T
- B. G to A
- C. C to U
- D. G to T

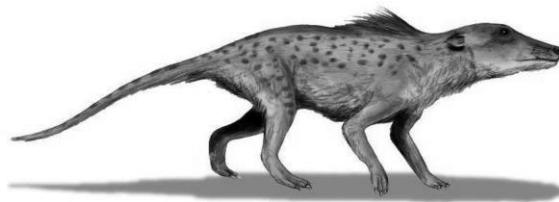
Question 23

A frameshift mutation usually results from:

- A. a base substitution
- B. a base deletion only
- C. a deletion of three adjacent bases
- D. a base insertion or deletion

Questions 24 and 25 refer to the following information and diagram.

Pakicetus, a fossil discovered in Pakistan, lived 50 million years ago (shown below). Although it primarily lived on land it had a unique inner ear shape found only in whales and a long skull typical of whales.



Pakicetus

Question 24

In view of this statement, a *Pakicetus* fossil would be a/an:

- A. index fossil
- B. link fossil
- C. transitional fossil
- D. trace fossil

Question 25

To estimate the relative age of *Pakicetus* fossils, palaeontologists would most likely have used:

- A. carbon-14 dating
- B. radiometric dating
- C. DNA hybridisation with whale DNA
- D. index fossils

Question 26

Scientific data shows that there is regularity in the rate of change of any given protein over time. The term applied to this regularity is:

- A. gradual adaptation
- B. micro evolution
- C. a molecular clock
- D. regular mutations

Question 27

Genetic drift results in changes in allele frequencies due to:

- A. small populations
- B. chance
- C. natural selection
- D. non-random mating

Question 28

Genetic flow results in changes in allele frequencies due to:

- A. the movement of genes between species populations.
- B. the joining up of one species with another.
- C. the effect of mutations in neighbouring populations.
- D. the hybridisation of two different species in related populations.

Question 29

A German religious group, the Baptist Brethren, migrated to the USA between 1719 and 1729 to avoid religious persecution. They rarely marry outside their community and lead a simple life with few modern tools. Scientists compared the frequency of MN blood group systems in current Baptist Brethren communities with the original German populations and the neighbouring USA populations. The results are tabulated below:

| Population | M | MN | N |
|------------------|-------|-----|-------|
| German | 30% | 50% | 20% |
| USA | 30% | 50% | 20% |
| Baptist Brethren | 44.5% | 42% | 13.5% |

An explanation for these results would be:

- A. mutation and natural selection.
- B. gene flow and reproductive isolation.
- C. population bottle neck and inbreeding depression.
- D. founder effect and genetic drift.

Questions 30 and 31 refer to the following information:

The red legged mite is a common pest of pastures in southern Australia and the south of Western Australia. In some areas it has developed resistance to synthetic pyrethroids, the insecticides used to eliminate them.

Question 30

The best explanation for the development of this resistance would be:

- A. pyrethroid chemicals cause mutations in the red legged earth mites making them resistant.
- B. the original gene pool of the red legged earth mites included genes that gave resistance to the pyrethroids.
- C. the pyrethroids have lost their toxicity over time by chemical breakdown.
- D. all insects, including the red legged earth mites, become resistant to insecticides over time.

Question 31

It has been recommended that the use of pyrethroid insecticides for the red legged earth mites be stopped in all areas. If the use of pyrethroids is halted it would be expected that:

- A. the frequency of resistant mites will continue to increase.
- B. the mutation rate due to pyrethroids will decline.
- C. the frequency of resistant mites will remain constant.
- D. the frequency of non-resistant mites will steadily increase.

Question 32

A student inoculated 50 full nutrient agar plates with a particular species of bacteria, labelling them group A. She then inoculated another 50 agar plates, group B, with the same species of bacteria except these agar plates were low in a particular nutrient. She incubated all 100 plates at 37°C for several days. She then measured the average colony size and found that the average size for group A was twice the size of group B. A reasonable explanation for this observation would be that:

- A. the temperature of incubation for group B was less than for group A.
- B. natural selection acted on group B to favour slower growing bacteria.
- C. the growth rate of group B was slower due to the lower concentration of a particular important nutrient.
- D. the lower concentration of an important nutrient in group B acted as a selection pressure to select naturally occurring slow growing bacteria.

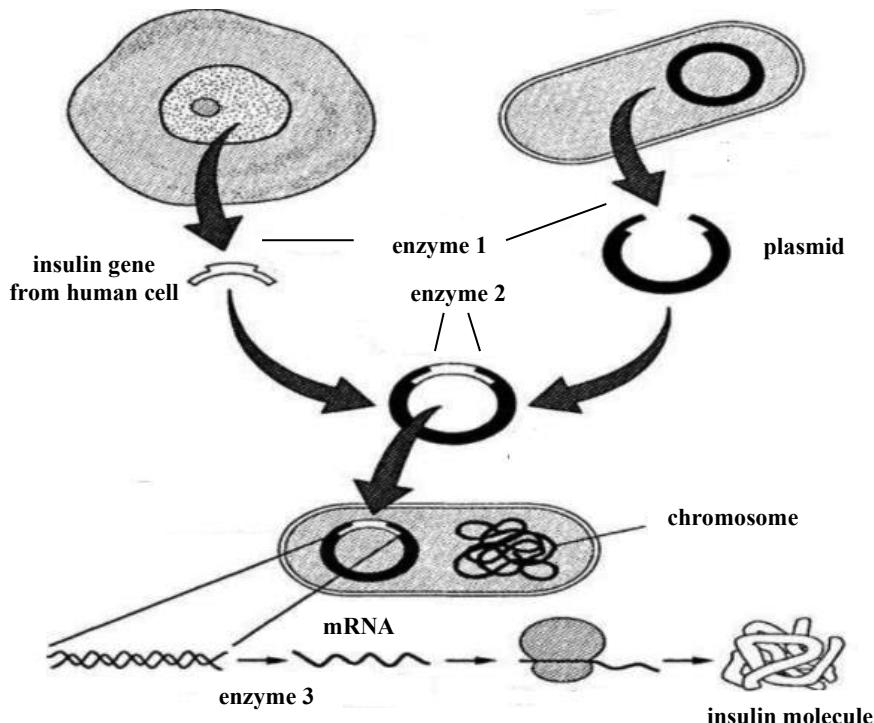
Question 33

A species of grass that grows in an area of inconsistent rainfall has a gene for leaf shape with different alleles for curly leaves and flat leaves. In years with low rainfall plants with curly leaves reproduced better than the plants with flat leaves. The opposite occurred in years of high rainfall. This would result in:

- A. a uniformity in the grass population.
- B. directional selection of the grass population.
- C. gene flow in the grass population.
- D. maintaining the genetic variation in the grass population.

Questions 34 and 35 refer to the following information and diagram.

Human insulin can be produced by inserting the gene for human insulin into bacteria. Some of the stages for this procedure and the enzymes involved are shown in the diagram below.



Question 34

The correct names of the enzymes for each stage are:

- | enzyme 1 | enzyme 2 | enzyme 3 |
|-----------------------------|--------------------------|--------------------|
| A. DNA nuclease | DNA ligase | DNA polymerase |
| B. restriction endonuclease | DNA ligase | RNA polymerase |
| C. DNA ligase | restriction endonuclease | protein synthetise |
| D. restriction endonuclease | DNA nuclease | RNA polymerase |

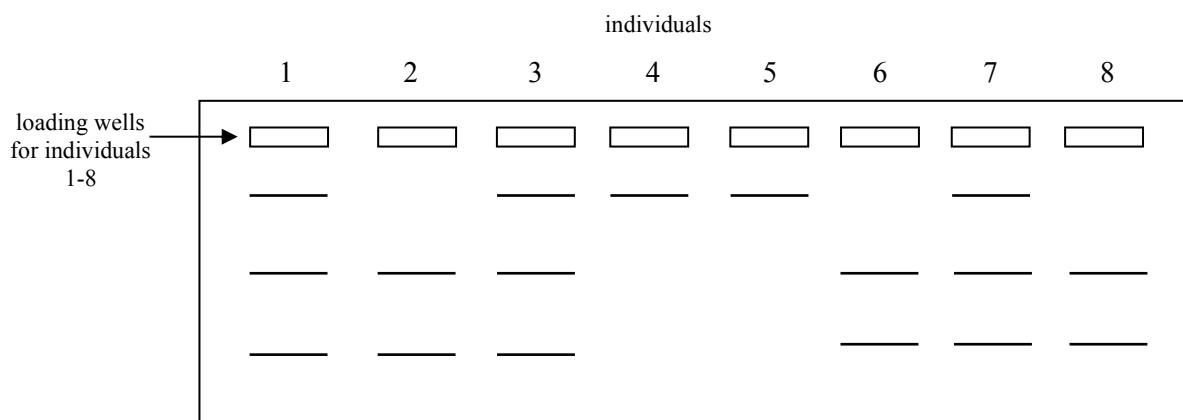
Question 35

The process shown above is known as:

- A. transformation
- B. transfection
- C. genetic mutation
- D. translocation

Question 36

The disease Duchene's muscular dystrophy (DMD), is due to a mutation in the gene dystrophin that codes for the dystrophin protein. Genetic testing can be used to test if an individual is a non-symptomatic carrier with (one copy of the normal allele and one copy of the mutated allele for DMD. A 2kb section of the normal allele can be cut with *pstI* enzyme to give 1.5kb and 0.5kb fragments. The same 2kb section of the DMD allele cannot be cut by *pstI*. Eight family members were tested for the DMD allele. The diagram below shows the electrophoresis gel results for the presence of the allele:

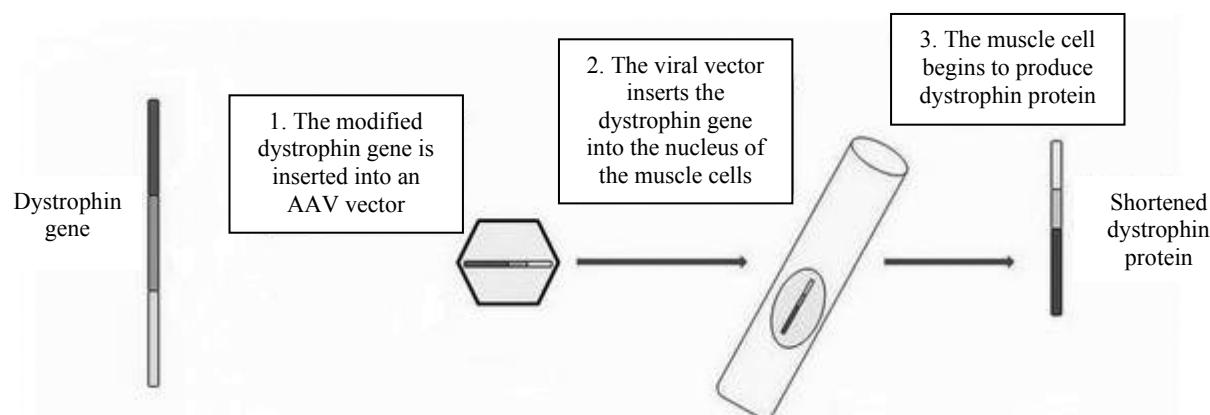


Using the information and diagram above, individuals who are likely to suffer from DMD are:

- A. 2 and 8
- B. 1, 2, 3, 6, 7 and 8
- C. 4 and 5
- D. 1, 3, 4, 5 and 7

Question 37

One treatment being trialled for DMD is to insert a modified dystrophin gene into a viral vector to deliver the modified gene into the patient's muscle cells as shown in the diagram below:



Such a procedure:

- A. is pre-clinical testing for an inherited condition.
- B. cures and prevents inheritance of the condition.
- C. is termed gene therapy for an inherited condition.
- D. is termed live vector vaccinations for an inherited condition.

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

A group of primates consists only of orang-utans, gibbons, gorillas, chimpanzees and humans.

Question 38

This group of primates is called:

- A. homininas
- B. hominids
- C. hominoids
- D. hominins

Question 39

The characteristic that sets this group apart is:

- A. an S shaped spine
- B. 5 cusps to their molar teeth
- C. nails not claws
- D. small zygomatic arch

Question 40

Members of the genus *Australopithecus*, are believed to have displayed a critical advance in human evolution. This important step would have been:

- A. the ability to walk upright on two feet
- B. a large brain case
- C. fashioning or making tools for use
- D. development of the precision grip

END OF SECTION A

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

This section consists of 10 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

Messenger RNA (mRNA) and transfer RNA (tRNA) are both made up of polynucleotides.

- a Name the nitrogenous bases that make up these polynucleotides.

(1 mark)

- b Complete the table below to describe the differences between mRNA and tRNA in eukaryotic cells.

| | mRNA | tRNA |
|------------------------------|-------------|-------------|
| shape of the molecule | | |
| function | | |

(2 marks)

- c Describe the two functional regions of tRNA.

region 1 _____

region 2 _____

(2 marks)

- d What happens to mRNA and tRNA after they complete their role in protein synthesis?

mRNA _____

tRNA _____

(2 marks)

Total 7 marks

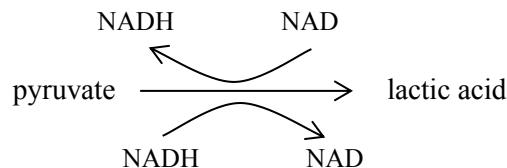
Question 2

Scientists compared the density of the cristae in the mitochondria from the thigh leg muscles of highly trained athletes with the density of cristae in the mitochondria of non-athletes. They found the density was up to 23% greater in the athletes than the non-athletes.

- a Considering the function of the cristae, what is the significance of this difference between the two groups?

(2 marks)

Human skeletal muscle cells can respire both aerobically and anaerobically. In muscle cells with low oxygen, pyruvate is converted to lactic acid. When oxygen is readily available again the lactic acid can be converted back to pyruvate. This is shown in the diagram below:



- b Considering the above diagram and your knowledge of anaerobic cellular respiration, give **two** advantages of the muscle being able to respire anaerobically in reduced oxygen.

Advantage 1 _____

Advantage 2 _____

(2 marks)

- c Why is it important that the lactic acid is converted back to pyruvate when oxygen is available?

(1 mark)

While cells can survive for a short period of time in anaerobic conditions, the lack of oxygen will result in eventual cell death.

- d Explain why the presence of oxygen is essential for the survival of a cell.

(2 marks)

The enzyme ATP synthase that are responsible for the production of ATP can be found in the membranes of prokaryotic cells and mitochondria.

- e Name and describe the theory that supports this observation.

(2 marks)

Total 9 marks

Question 3

UV light damages DNA. If the damaged DNA cannot be repaired then apoptosis is triggered.

- a Suggest **two** other factors that can trigger apoptosis.

(2 marks)

DNA damage triggers the release of BAX protein that in turn brings about the release of cytochrome c.

- b Name the organelle that releases cytochrome c.

(1 mark)

- c What role does the release of cytochrome c play in apoptosis?

(2 marks)

Bcl2 is a protein product of the Bcl2 gene that prevents the release of cytochrome c. The ratio BAX/Bcl2 is considered important in the balance of apoptosis.

- d Suggest a possible outcome when this ratio is low. Explain your answer.

(2 marks)

Total 7 marks

Question 4

In late 2019 into early 2020 there was an outbreak of a disease named COVID-19, due to a new strain of coronavirus, SARS-CoV-2, that caused pneumonia-like symptoms that could be fatal. The outbreak started in the city of Wuhan in China, which is a central transport hub with a transport network to many other cities. One theory is that the virus originated in the live animal market and was able to spread to humans from an animal source. Such a virus is called a zoonotic virus. Some zoonotic pathogens can infect many different animal hosts. Coronaviruses are RNA viruses, i.e. their genetic material is a single strand of RNA unlike double stranded DNA viruses.

The World Health Organisation announced in March 2020 that the disease, called COVID-19, was in fact a pandemic.

- a What is the difference between an epidemic and a pandemic?

(2 marks)

- b Explain why it is difficult for viruses that infect an animal cell to infect human cells.

(2 marks)

- c Suggest how the SARS-CoV-2 virus spread so rapidly to other countries.

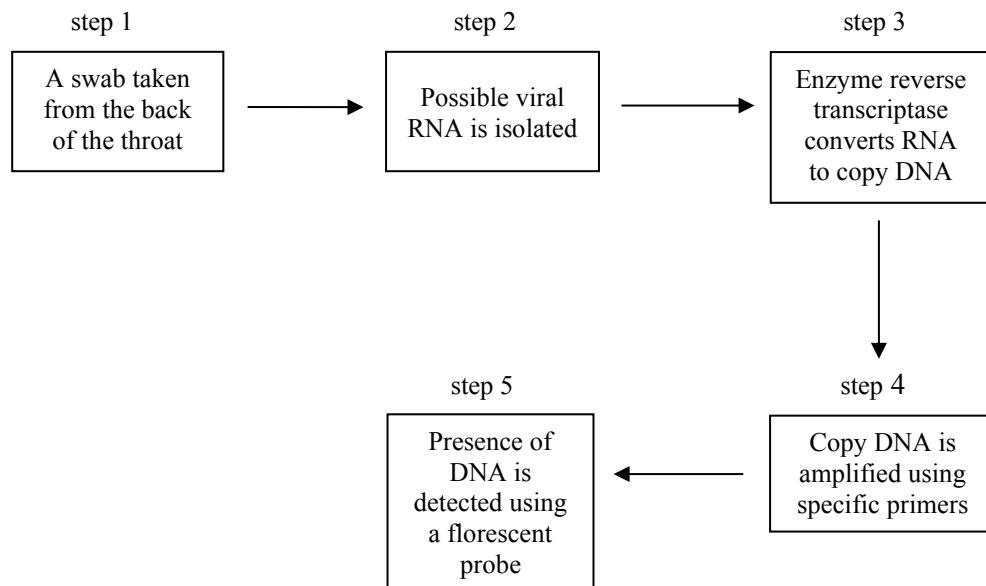
(1 mark)

Immediate actions by public health authorities were put in place in China and later other countries.

- d Give **two** measures that public health authorities can implement to prevent the spread of such a disease.

(2 marks)

In order to contain the virus, it is necessary to perform tests to see who currently has it and who has had it and recovered. One test is shown in the flow diagram below.



- e Name the process represented by step 4.

(1 mark)

- f Why would this test not be suitable if the individual has recovered from the infection?

(1 mark)

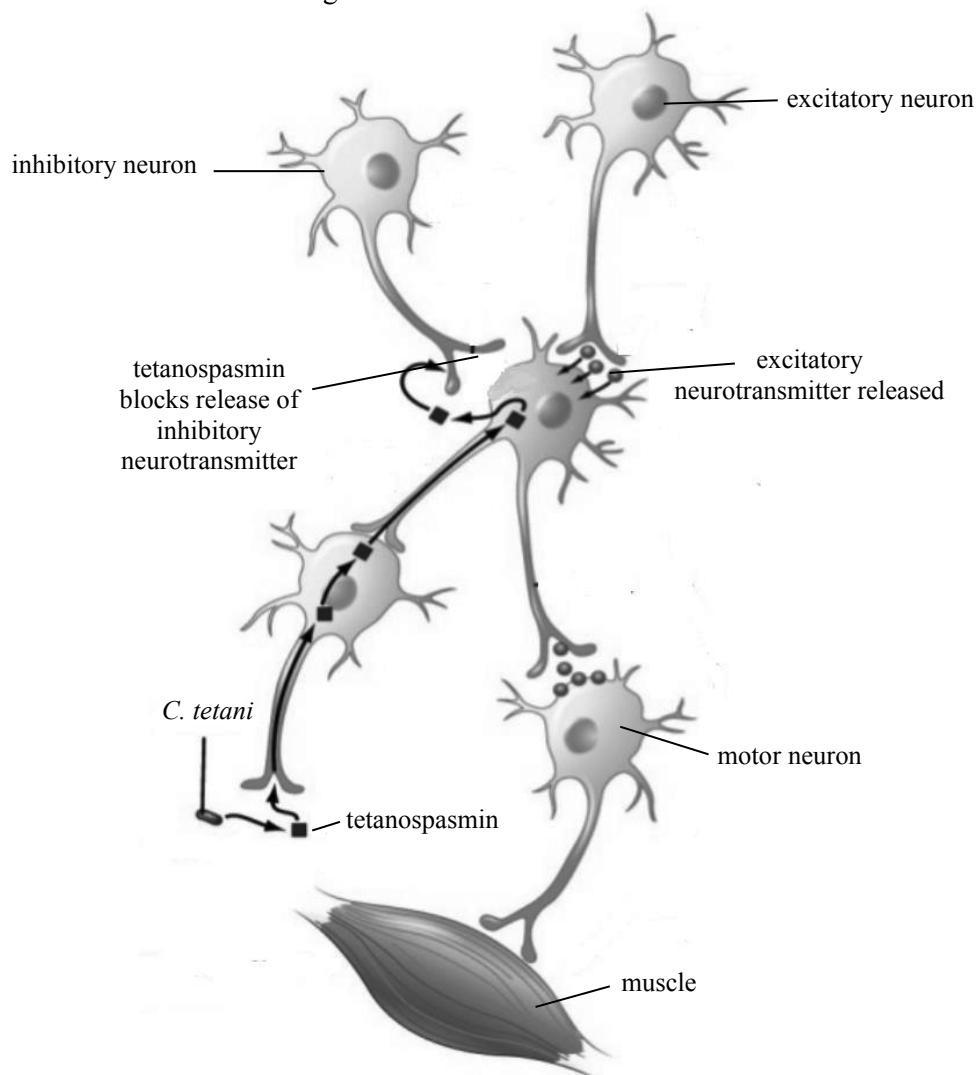
- g Suggest an appropriate test if the individual has just recovered from the infection?

(1 mark)

Total 10 marks

Question 5

The soil bacterium, *Clostridium tetani*, produces the neurotoxin tetanospasmin. When an individual gets a wound, through which *C. tetani* enters, the bacteria produce tetanospasmin. Tetanospasmin moves along the axon of peripheral nerves to the central nervous system. Once this neurotoxin enters nerve cells in the central nervous system, it blocks the release of neurotransmitters across the synapse of inhibitory neurons resulting in the disease tetanus. The diagram below shows the movement of the neurotoxin:



- a When a tetanus bacterium enters a wound, describe the body's immediate defence response.

Unfortunately, infections with *C. tetani* result in the disease tetanus in the unimmunised individual. The individual with tetanus suffers painful muscle spasms brought on by any stimulus. This can lead to difficulty in breathing and often death.

- b** Use the previous diagram to explain why an individual having contracted tetanus experiences often uncontrollable muscle spasms.

(2 marks)

In Australia, children are vaccinated at the ages of 2 months, 4 months, 6 months, 18 months and 4 years. The combined doses contain vaccines against diphtheria, whooping cough and tetanus. Occasionally parents refuse to get their children vaccinated saying that they will rely on herd immunity to protect their children.

- c** What is ‘herd immunity’?

(1 mark)

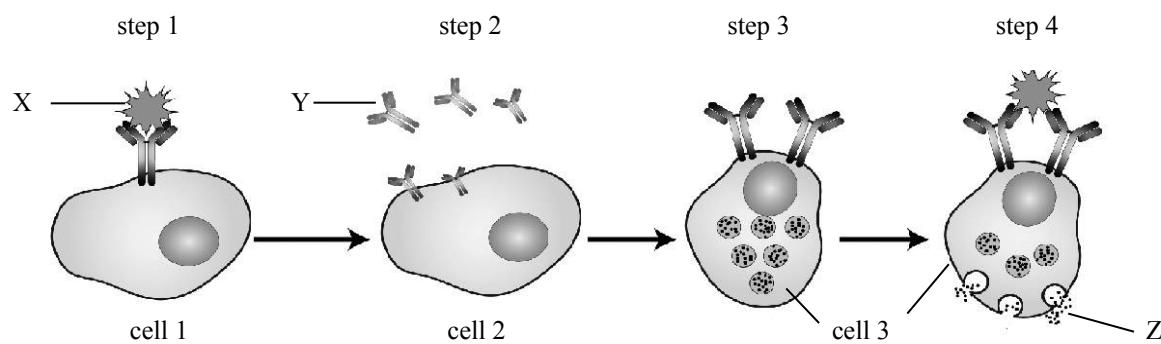
- d** Can these unvaccinated children rely on herd immunity in the case of tetanus? Explain your answer.

(1 mark)

Total 5 marks

Question 6

The following diagram shows the steps in an allergic response:



Name each cell and molecule or substance as indicated below **and** describe what is happening in each step.

a name of cell 1 _____

Description of what is happening in **step 1 including naming X**:

(1 + 1 + 1 = 3 marks)

b name of cell 2 _____

Description what is happening in **step 2 including naming Y**:

(1 + 1 = 2 marks)

c name of cell 3 _____

Description of what is happening in **step 3**:

(1 + 1 = 2 marks)

d Description of what is happening in **step 4 including naming Z**:

(1 + 1 = 2 marks)

Total 9 marks

Question 7

Three vertebrate species are shown below (not drawn to scale).



hippopotamus
class Mammalia



pig
class Mammalia



whale
class Mammalia



hippopotamus foot



pig foot



whale flipper

The traditional means of determining relatedness of species used structural morphology.

- a Using this method which **two** organisms out of the three shown above, would be considered to be more closely related? Explain your answer.

(2 marks)

A more modern technique of determining relatedness between species is based on comparing nucleotide sequences of a common gene. Below is a sequence of nucleotides of a common gene.

| | |
|--------------|---|
| pig | CCATTGTTCCAAGCGTAAA GGAATGCCCTTCCCTAAATC |
| hippopotamus | CTATCCTTCCTAACGCATAAAA GAAATGCCCTCTCTAAATC |
| whale | CTATCCTTCCTAACGCATAAAA GAAATGCGCTTCCCTAAATC |

- b Use the data given to draw, in the space below, a phylogenetic tree (not to scale) to show the relatedness between these three species.

(2 marks)

- c Explain why you decided to draw the phylogenetic tree the way you did.

(2 marks)

Amino acid sequences of proteins can also be used to demonstrate relationships between species. The protein cytochrome c is often used to make comparisons between species.

- d Suggest why cytochrome c is often used in this analysis.

(1 mark)

Total 7 marks

Question 8

Golden Rice refers to GMO rice plants modified to produce beta-carotene (also called provitamin A) in their grain, which is vital for preventing childhood blindness. This latest version of Golden Rice contains three added genes. Two specific enzymes in the β -carotene biosynthesis pathway are taken from bacteria and maize. The third specifies a (non-antibiotic) selectable marker protein used in the modification process.

The following information comes from a series of articles. Read the information and answer the questions that follow it.

The Philippines has become the first country with a serious vitamin A deficiency (VAD) problem to approve Golden Rice. In the Philippines, many children under 5 years old are severely vitamin A deficient, according to the World Health Organization, even though most of them are given vitamin A supplements. Vitamin A deficiency affects the immune system and makes children vulnerable to diseases, as well as leading to blindness. But a new study finds that most families at risk for VAD can't grow Golden Rice themselves, and most commercial farmers won't grow it either.

"Many families with Vitamin A deficient kids don't even have rice land to plant it," said Glenn Davis Stone, professor of sociocultural anthropology and environmental studies in Arts and Sciences at Washington University in St Louis and co-author of a new paper in the journal *Technology in Society*. "And those in the mountains won't plant it because it has been bred into the lowland varieties of rice known as IR-64 and RSC-82."

Golden Rice still has to be approved for commercial sale and still needs a company to grow marketable quantities of seed. Proponents' claim that the rice would be given free to farmers is false. No one has offered to produce and distribute the rice seed for nothing.

Golden Rice has to be crossed with local varieties in order to be ready to cultivate. Golden Rice researchers are still working to develop varieties that have yield, pest resistance and other qualities that make them suitable for farmers in Asia.

The claim that Golden Rice will remedy vitamin A deficiency remains unproven. Vitamin A is fat-soluble, and children with VAD rarely have fats in their diet. Moreover, they usually suffer from gut parasites and infections that make it harder to convert beta carotene to vitamin A.

"Up to now, proponents have failed to address concerns on the Golden Rice's negligible beta-carotene content, its fast degradation and the possible toxicity associated with the beta-carotene degradation," said Cris Panerio, National Coordinator of MASIPAG, a farmers network in the Philippines which is part of a pan-Asian network of more than 30 groups called the Stop Golden Rice! Network, in a December 2019 statement.

References

<https://theconversation.com/the-philippines-has-rated-golden-rice-safe-but-farmers-might-not-plant-it-129956>

<https://cban.ca/wp-content/uploads/Golden-Rice-Factsheet-2019.pdf>

<https://cban.ca/gm-golden-rice-approved-as-safe-to-eat-in-philippines-but-ability-to-provide-vitamin-a-remains-unevaluated/>

- a What term, other than a genetically modified organism can be used to describe Golden rice.
Support your answer using the data provided.

(2 marks)

- b** Using the previous information from the articles, complete the table below describing **two** social implications and **two** biological implications relevant to the use of Golden Rice.

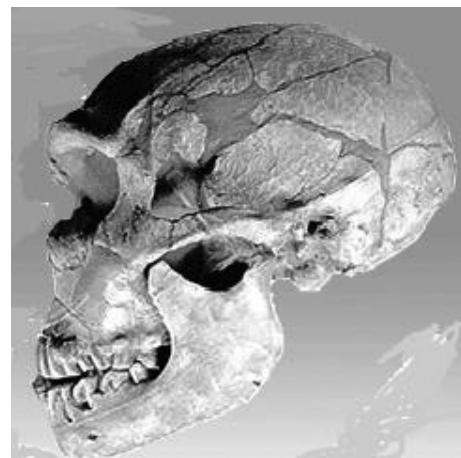
| | |
|------------------------------------|--|
| Two social implications | |
| Two Biological implications | |

(4 marks)

Total 6 marks

Question 9

Twelve *Homo erectus* skulls were discovered in a bone bed located about 20 m above the Solo River at Ngandong (Central Java, Indonesia) between 1931 and 1933. Dating techniques were not as good then but recently these fossil skulls were dated as between 108 000 – 117 000 years old, making them the most recent fossils of *Homo erectus*.

*Homo sapiens**Homo erectus*

- a Name a more modern technique that could have been used to date these fossils.

(1 mark)

- b Referring to the skulls shown above, give **two** features that are different between *Homo erectus* and *Homo sapiens*.

feature 1 _____

feature 2 _____

_____ (2 marks)

- c What other evidence from the skull supports the fact that *Homo erectus* walked upright?

_____ (1 mark)

About 120 000 to 110 000 years ago the temperature rose and Java changed from open woodland to dense rainforest becoming wetter and more humid. The Ngandong site included the bones of animals better suited to a woodland environment. No fossils of *Homo erectus* have been found in the rainforest environment since this time.

- d Suggest **two** explanations that explain this observation.

explanation 1 _____

explanation 2 _____

(2 marks)

Total 6 marks

Question 10

Students investigated respiration in germinating and non-germinating pea seeds. To measure the respiration rate, they measured the uptake of oxygen over time using vials with pipettes inserted, called respirometers.

To each vial they added:

1. potassium hydroxide (KOH) soaked cotton wool to absorb CO₂, forming solid potassium carbonate
2. dry non-absorbent cotton wool

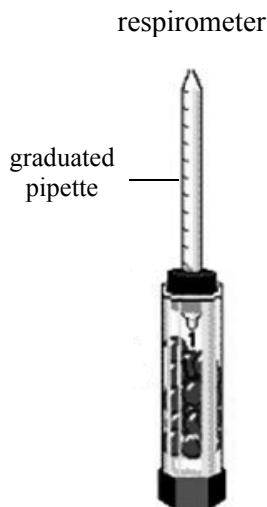
Then they added the following to each vial:

vial 1 – 30 germinating peas only

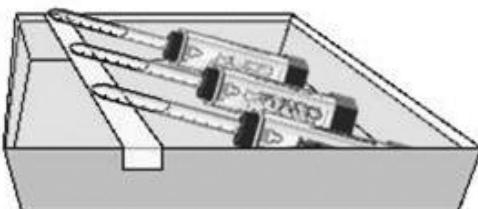
vial 2 – 30 non-germinating peas and enough glass beads so that the total volume was equal to vial 1

vial 3 – glass beads only so the total volume was equal to vial 1

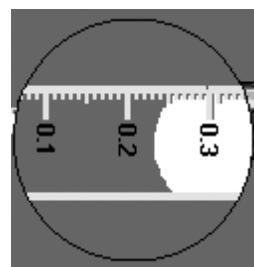
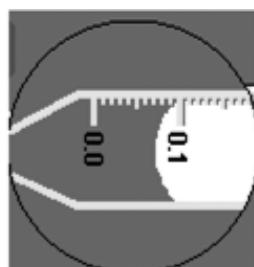
Each vial was capped with a stopper and a pipette with the point facing upwards to make a respirometer as shown in the diagram below:



The 3 respirometers were then partly placed in a water bath as shown below resting on tape for 5 minutes:



The respirometers were then fully submerged. As the volume of the gas changed, the movement of the water into each pipette was measured in the respirometer.



- a** State the hypothesis being tested in this investigation.

(1 mark)

- b** State the independent variable and the dependent variable in this investigation.

independent variable

dependent variable _____ (2 marks)

- c List **two** variables that need to be controlled in this experiment.

2 _____ (2 marks)

- d** Why were the respirometers rested in the water bath for 5 minutes before the initial volume of gas was measured?

(1 mark)

- e Potassium hydroxide (KOH) absorbs carbon dioxide to form solid potassium carbonate. Explain why it was necessary to add KOH to the respirometers?

(2) (1)

- f. How does the movement of water into the pipette over time relate to the rate of respiration?

(1 mark)

- g** What results would support the hypothesis in this experiment?

(1 mark)

- h** Suggest **three** possible sources of error in this experimental setup?

(3 marks)

- i** What was the purpose of the vial containing only glass beads **and** how could it be used to improve the results of the experiment?

(1 mark)

Total 14 marks

END OF TRIAL EXAMINATION

Acknowledgements

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