STAV PUBLISHING

**STAV Publishing 2012**

**Student name**

# BIOLOGY

## Unit 4

## Trial Examination

### QUESTION AND ANSWER BOOK

**Total writing time: 1 hour 30 minutes**

### Structure of book

| Section | Number of questions | Number of marks |
|---|---|---|
| A | 25 | 25 |
| B | 6 | 50 |
| | **Total** | **75** |

- 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 20 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.
- 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.

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ABN 61 527 110 823

# *STAV Publishing*
## 2012

# BIOLOGY
## Unit 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 |
|---|---|---|---|
| 1 | A B C D | 14 | A B C D |
| 2 | A B C D | 15 | A B C D |
| 3 | A B C D | 16 | A B C D |
| 4 | A B C D | 17 | A B C D |
| 5 | A B C D | 18 | A B C D |
| 6 | A B C D | 19 | A B C D |
| 7 | A B C D | 20 | A B C D |
| 8 | A B C D | 21 | A B C D |
| 9 | A B C D | 22 | A B C D |
| 10 | A B C D | 23 | A B C D |
| 11 | A B C D | 24 | A B C D |
| 12 | A B C D | 25 | A B C D |
| 13 | A B C D | | |

## SECTION A - Multiple Choice Questions

**Specific instructions for Section A**

This section consists of 25 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

Which of the following describes the different polynucleotide strands of DNA, mRNA and plasmids?

| | DNA | mRNA | plasmid |
|---|---|---|---|
| **A.** | single- stranded | double-stranded | single-stranded |
| **B.** | double-stranded | single-stranded | double-stranded |
| **C.** | double-stranded | double-stranded | double-stranded |
| **D.** | double-stranded | single-stranded | single-stranded |

### Question 2

Radioactive adenine was added to an actively reproducing culture of bacteria. Time was allowed for one of the original bacterial cells to divide into two daughter cells in the presence of the radioactive adenine. It would be reasonable to state that:

**A.** one of the two daughter cells would have radioactive DNA but not the other one.
**B.** neither of the two daughter cells would have radioactive DNA.
**C.** both of the two daughter cells would have radioactive DNA.
**D.** DNA replication would not occur as there was no radioactive thymine to pair with the radioactive adenine.

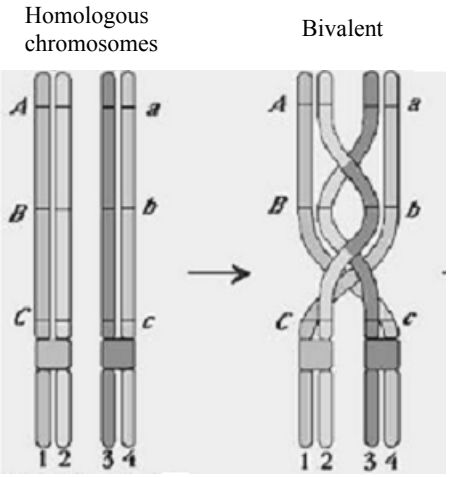
### Question 3

The plant, *Melandrium album,* shows the same sex-determining pattern as humans. An X-linked gene in this plant governs leaf shape. The dominant allele **B** produces broad leaves, and the recessive allele **b** for the same gene produces narrow leaves. Only pollen containing the **B** allele is able to survive to fertilise a female ovum. Female ova are able to survive with either allele. A heterozygous broad-leafed female was crossed with pollen from a broad-leafed male plant. The offspring plant that would result from this cross would be expected to be:

**A.** only female and board-leafed.
**B.** only male and narrow-leafed.
**C.** half male and half female and all broad-leafed.
**D.** all female broad-leafed and half the males broad-leafed and half narrow-leafed.

***Questions 4 and 5 refer to the following diagram.***

The following structures are found in a cell undergoing cell division.




**Question 4**

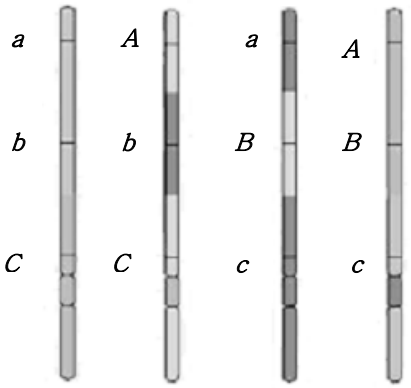
This process occurs in:

**A.** meiosis I
**B.** meiosis II
**C.** mitosis I
**D.** mitosis II

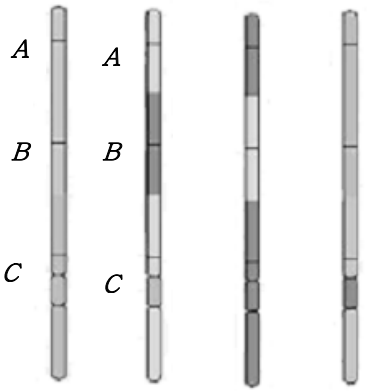
**Question 5**

The possible products of this process would be:

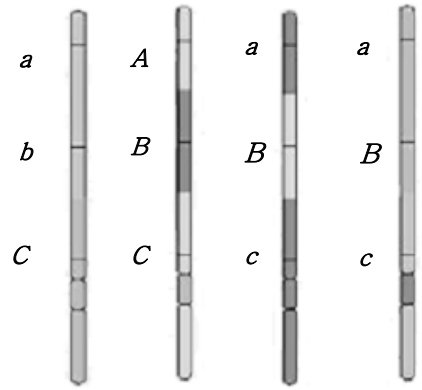
**A.**



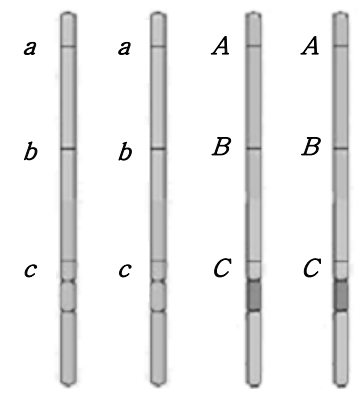

**B.**




**C.**




**D.**



***Questions 6 and 7 refer to the following information.***

A species of plant produces either blue or white flowers and has either short or tall stems. A pure-breeding plant that has blue flowers and tall stems is crossed with a pure-breeding plant with white flowers and short stems. The offspring all had blue flowers and tall stems.

**Question 6**

Based on this data, it would be reasonable to state that:

**A.** the genes for flower colour and stem length are closely linked.
**B.** the genes for flower colour and stem length are not linked.
**C.** independent assortment has not occurred.
**D.** the white flower allele and the tall stem allele occur at the same locus and the blue flower allele and the short stem allele occur at another locus.

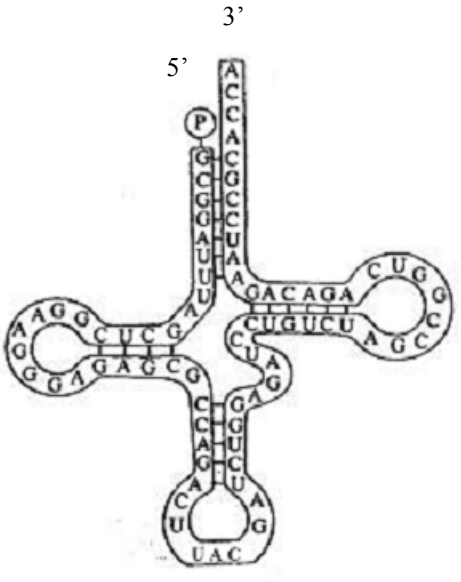
**Question 7**

These offspring were then test crossed. It would be reasonable to expect that:

**A.** three quarters of the plants produced would have tall stems.
**B.** half the plants with white flowers would have tall stems.
**C.** all the plants with blue flowers would have tall stems.
**D.** three quarters of the plants would have white flowers.

**Question 8**

A tRNA molecule is shown below.

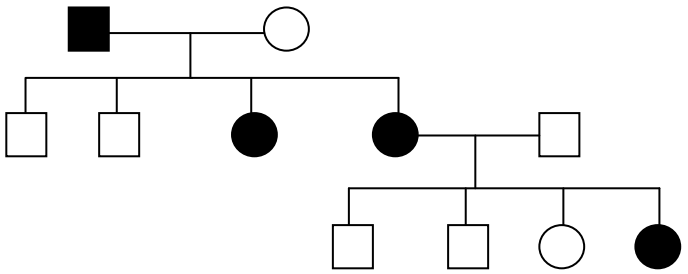



The mRNA codon that this tRNA would interact with would be:

**A.** 3' AUG 5'
**B.** 3' UAC 5'
**C.** 3' ATG 5'
**D.** 5' ATG 3'

**Question 9**

The following pedigree shows the inheritance of a particular condition.



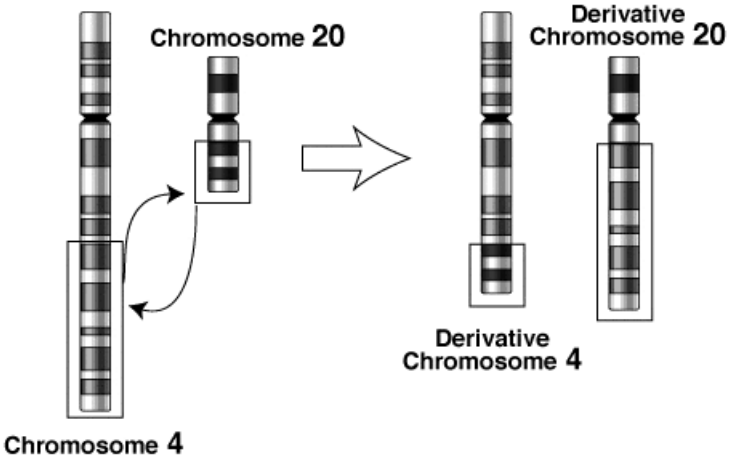
Modes of inheritance:

I autosomal recessive
II autosomal dominant
III X-linked recessive
IV X-linked dominant

The mode of inheritance shown in this pedigree could be:

**A.** I only
**B.** I and II only
**C.** I, II and IV only
**D.** I, II, III and IV

**Question 10**




The diagram above represents a:

**A.** transfection
**B.** transformation
**C.** translocation
**D.** transmutation

***Questions 11 and 12 refer to the following information.***

The shape of radishes is governed by two alleles, $S^L$ and $S^R$.

$S^LS^L$ gives a phenotype of long
$S^RS^R$ gives a phenotype of round
$S^LS^R$ gives a phenotype of oval

**Question 11**

This type of inheritance is:

**A.** dominant- recessive
**B.** co-dominance
**C.** sex-linked
**D.** all dominant

**Question 12**

A farmer crossed long radishes with oval radishes. The expected ratio in the $F_1$ offspring would be:

**A.** ¾ long ; ¼ round
**B.** ¾ long ; ¼ oval
**C.** ½ long ; ½ oval
**D.** all oval

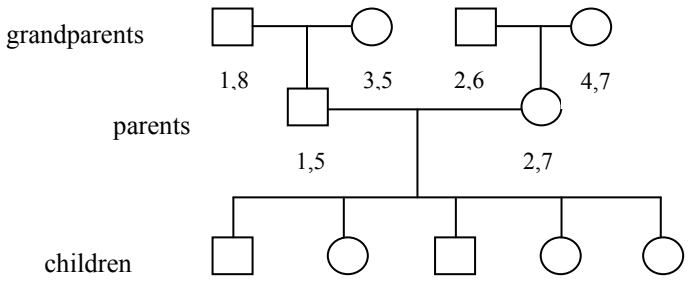
**Question 13**

A sufferer had the condition cystic fibrosis. This was due to a point mutation in which thymine had replaced cytosine at nucleotide 1609. This resulted in the glutamine codon, CAG, now being replaced by the STOP codon TAG. The protein resulting had only 493 amino acids instead of the normal 1480 amino acids. This is an example of:

**A.** a silent mutation.
**B.** a missense mutation.
**C.** an insertion mutation.
**D.** a nonsense mutation.

**Question 14**

The following pedigree shows the inheritance of a RFLP marker in a family.




All possible genotypes that the children could inherit for this RFLP would be:

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

***Questions 15 and 16 refer to the following information.***

The colour of bell capsicums can be pale yellow, dark yellow, green, red and purple.

The following genes contribute to the colours.

| | | |
|---|---|---|
| The timing of chlorophyll elimination | **Y** | early |
| | **y** | normal |
| The colour of the carotinoids | **R** | red |
| | **r** | yellow |
| Regulation of carotinoid deposition | **C** | normal |
| | **$c_1$** | lower concentration |
| | **$c_2$** | lower concentration |

Some possible genotypes and their phenotype are shown below.

| Genotype | colour |
|---|---|
| **Y− rr $c_1c_2$** | pale yellow |
| **Y− rr $Cc_2$** | darker yellow |
| **Yy rr CC** | green |
| **Y− R− CC** | red |
| **Yy Rr CC** | purple |
| **Y− Rr $Cc_2$** | pale yellow |

**Question 15**

The number of genes involved is:

**A.** 7
**B.** 3
**C.** 4
**D.** 6

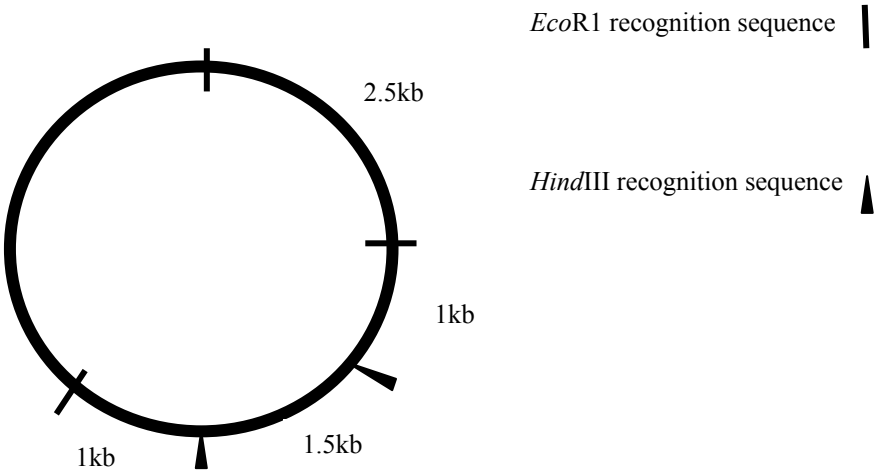
**Question 16**

It is reasonable to state that:

**A.** these genes would all be on the same chromosome.
**B.** capsicums with the same phenotype would have the same genotype.
**C.** this is an example of polygenetic inheritance.
**D.** the environment would have no influence on the final phenotype.

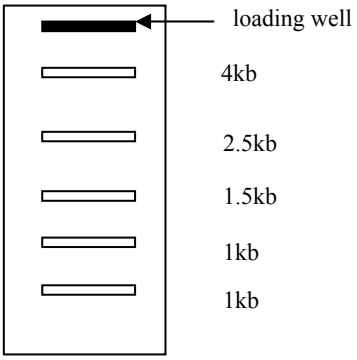
**Question 17**

A 10kb plasmid was cut using the restriction enzymes *Eco*R1 and *Hind*III. The cut plasmid was then run on a gel.

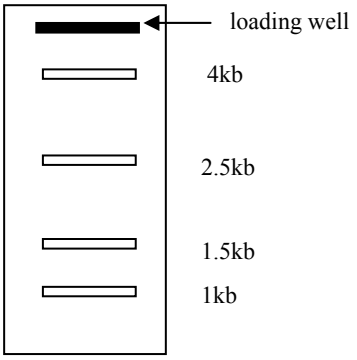



The diagram that best represents the gel after electrophoresis of the cut plasmid would be:

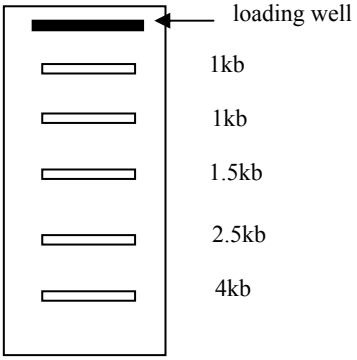
**A.**



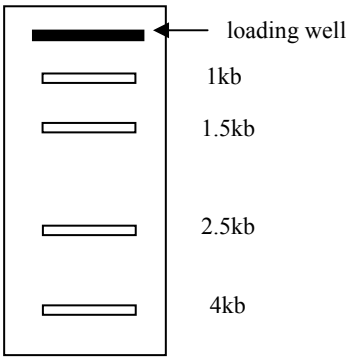

**B.**




**C.**




**D.**



**Question 18**

DNA can be sequenced using different coloured fluorescent dyes that bind specifically to a nucleotide. The binding may be according to the following:

| nucleotide | colour |
|---|---|
| A | green |
| T | red |
| G | yellow |
| C | blue |

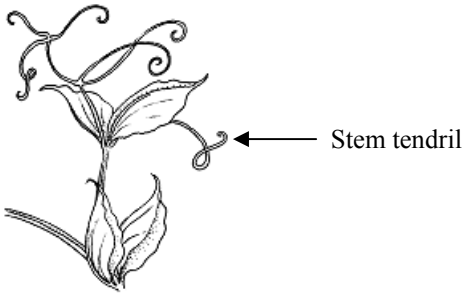
The DNA chain is sequenced by firstly making a series of complementary copies of the DNA that is to be sequenced such that each copy is one nucleotide longer than the previous one. The nucleotide at the end of each copy becomes attached to the specific coloured dye. The different colours are read off by a computer and the sequence can be determined. The following piece of DNA was sequenced and found to be:

**ATTGCACTGCAT**

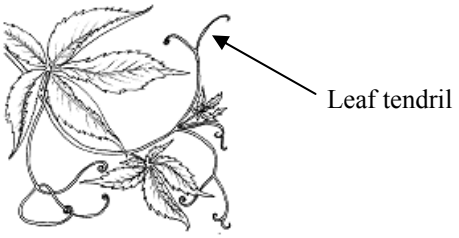
During the sequencing process:

**A.** the first copy would be green.
**B.** the fourth copy would be **ATTG** and would be yellow.
**C.** the final copy would have 12 nucleotides and would be red.
**D.** the fourth copy would be **TAAC** and would be blue.

***Questions 19 and 20 refer to the following diagrams and information***




Plant A




Plant B

In the diagrams above both plants have tendrils. In plant A the tendrils are formed from modified stems and in plant B the tendrils are formed from modified leaves.

**Question 19**

From an evolutionary point of view it would be reasonable to state that:

**A.** these are analogous structures resulting from convergence.
**B.** these are analogous structures resulting from divergence.
**C.** these are homologous structures resulting from convergence.
**D.** these are homologous structures resulting from divergence.

**Question 20**

It is reasonable to state that these two plants must have:

**A.** similar DNA sequences.
**B.** similar environmental selection pressures.
**C.** a recent common ancestor.
**D.** similar mRNA.

**Question 21**

*Glossopterus* was a fern that arose 299 million years ago. Fossils of *Glossopterus* have been found in all the Southern continents – southern Africa, Australia, southern India and Antarctica.

The distribution of these fossil remains is evidence of:

**A.** natural selection.
**B.** genetic drift.
**C.** continental drift.
**D.** convergent evolution.

**Question 22**

Growers have been warned that the green peach aphid, *Myzus persicae,* has developed a resistance to the insecticide, pirimicarb, which has been used extensively in Western Australia. The best explanation for the development of resistance would be:

**A.** the original gene pool in the green peach aphid included genes that gave resistance to the pirimicarb insecticide.
**B.** the pirimicarb insecticide stimulated the development of resistance in certain individuals and this was inherited.
**C.** the pirimicarb insecticide, being toxic, caused a mutation to occur in the aphids that was favourable to resistance and this was inherited.
**D.** insects naturally become resistant to insecticides used over a period of time.

**Question 23**

Lactose intolerance in human populations is the inability to digest milk sugar or lactose. The ability to digest lactose, or lactose tolerance, is present in higher proportions in European populations and populations that domesticated milk producing herds. A higher proportion of lactose intolerance is found in Asian populations and other populations that did not domesticate milk producing herds. Using this data it is reasonable to state that:

**A.** lactose intolerance is an example of cultural evolution.
**B.** lactose tolerance is due to the intake of large amounts of milk in the diet.
**C.** there would be no lactose tolerance in Asian communities.
**D.** milk in the diet acts a selective pressure to bring about natural selection of lactose tolerance.

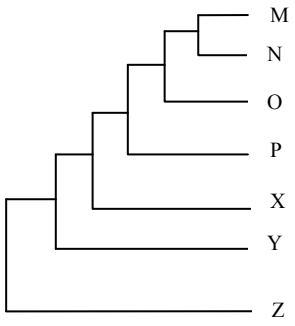
**Question 24**

Determining nucleotide substitutions in a particular gene is an important tool in determining evolutionary relationships between different species and enabling phylogenetic trees to be drawn. The following seven species of organisms, **M, N, O, P, X, Y** and **Z** were examined and the number of nucleotide substitutions between each was examined.

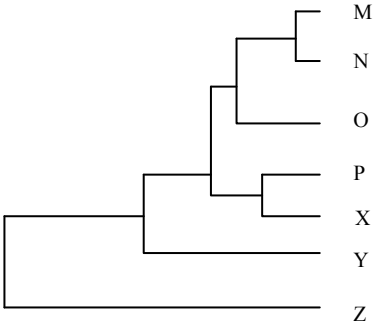
| Species | **N** | **O** | **P** | **X** | **Y** | **Z** |
|---|---|---|---|---|---|---|
| **M** | 35 | 75 | 127 | 125 | 161 | 271 |
| **N** | | 80 | 131 | 129 | 160 | 270 |
| **O** | | | 128 | 127 | 158 | 269 |
| **P** | | | | 55 | 156 | 273 |
| **X** | | | | | 152 | 270 |
| **Y** | | | | | | 275 |

Which of the following phylogenetic trees best represents the data?

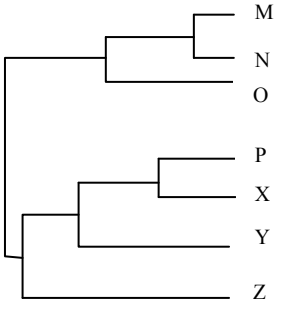
**A.**



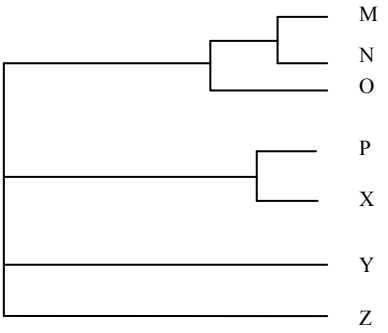

**B.**




**C.**




**D.**



**Question 25**

The "Out of Africa" hypothesis supports that:

**A.** All forms of hominin arose in Africa and migrated out of Africa.
**B.** Only *Homo erectus* and *Homo sapiens* migrated out of Africa.
**C.** *Homo sapiens* was the only hominin to migrate out of Africa.
**D.** There is a lack of variation in all *Homo sapiens* mitochondrial DNA.

**END OF SECTION A**

**SECTION B - Short Answer Questions**

**Specific instructions for Section B**

This section consists of 6 questions. There are 50 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**

Coat colour in mice is governed by a multiple allele series. The allele **A** is dominant and gives the agouti or normal grey colour. The allele **a** is recessive and gives a black colour. Another allele $\mathbf{A^y}$ is lethal in embryonic development in the homozygous state, but produces a yellow colour when in the heterozygous condition with either of the other two alleles.

**a** What is the maximum number of different alleles for colour, any single somatic cell in the mouse can have?

_____

(1 mark)

The following cross was carried out.

| Male | | Female |
|---|---|---|
| $\mathbf{A^yA}$ | x | $\mathbf{A^ya}$ |

**b** What colour is the female mouse? _____

What colour is the male mouse? _____

(1 mark)

**c** What would be the expected phenotype(s) of the offspring and in what ratio?

_____

(1 mark)

**d** What would be the expected genotype(s) of the offspring and in what ratio?

_____

(1 mark)

**Total 4 marks**

**Question 2**

Colour in onions is under genetic control. The dominant allele **R** produces red bulbs and its corresponding recessive allele **r** produces yellow bulbs. On another chromosome there is a gene that inhibits the expression of the colour alleles in its dominant form **I**, but allows the expression of colour in its recessive form **i**. If an onion plant carries the **I** allele it will be white.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Colour gene | **R** | : | red | Inhibitor gene | **I** | : | white colour |
| | **r** | : | yellow | | **i** | : | no inhibition of colour allele |

**a** Suggest how the inhibitor gene might work to produce an onion with no colour.

_____

_____

_____

(2 marks)

**b** Would all yellow onions have the same genotype? Explain your answer.

_____

_____

(2 marks)

**c** What would be the genotypes(s) for an onion with a white phenotype?

_____

(3 marks)

A pure breeding white onion was crossed with a pure breeding red onion. When the $F_1$ offspring were crossed, the $F_2$ generation produced 12 white onions, 3 red onions and 1 yellow onion.

**d** Based on this information what are the genotypes of the original parent onion plants?

**(i)** The pure white parent _____

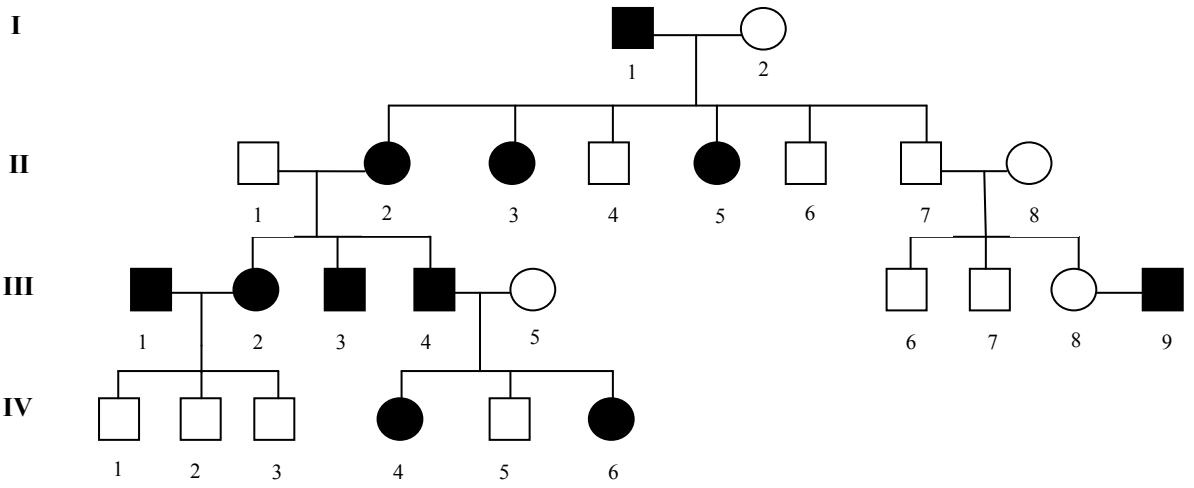
**(ii)** The pure red parent _____

(1 + 1 = 2 marks)

**Total 9 marks**

**Question 3**

A pedigree for the inheritance of the Xg blood group in humans is shown below.




**a** What is the most likely mode of inheritance shown?

_____

(1 mark)

**b** Give two reasons for your answer to **a**.

_____

_____

(2 marks)

**c** Individuals **III**8 and **III**9 wish to have children.

**(i)** What is the probability of having a girl with the Xg blood group?

_____

**(ii)** What is the probability of having a boy with the condition?

_____

(1 + 1 = 2 marks)

**Total 5 marks**

**Question 4**

The expression of genes within a cell is regulated or controlled.

**a** Why do genes need to be regulated?

_____

_____

(1 mark)

Genes can be regulated by sections of DNA called regulatory sequences and regulatory molecules. A regulatory sequence of DNA is a section of DNA upstream from the gene. Regulatory molecules or transcription factors are proteins that attach to the regulatory sequences of DNA that they recognise resulting in transcription taking place.

**b** What is transcription?

_____

(1 mark)

**c** Outline the steps in the transcription process.

_____

_____

_____

_____

(2 marks)

Modification of these regulatory sequences of DNA, rather than a change in the actual gene, is also a building block for evolution. Such a modification to a regulatory sequence of DNA can result in more or less gene product being expressed.

**d** What term is given to such a modification?

_____

(1 mark)

**e** Outline how such a modification of a regulatory sequence of DNA can result in a change in gene production.

_____

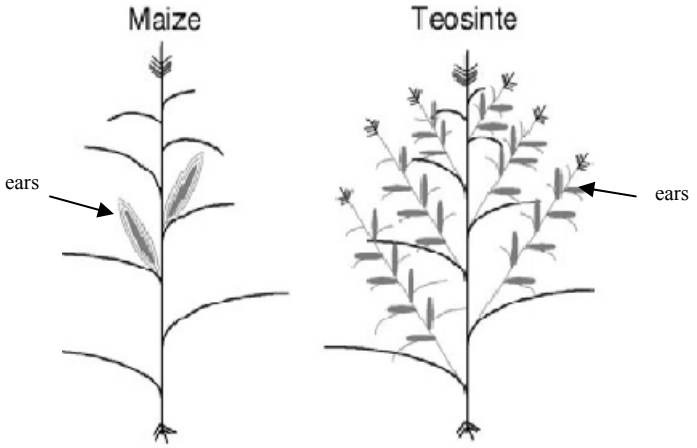
_____

_____

_____

(2 marks)

Corn or maize as we know it today has come originally from a grass plant *teosinte* species found in Mexico. The wild *teosinte* plant has a highly branched appearance and has many small ears of corn on its side branches. The tb1 gene is present in both modern corn and *teosinte*. This gene is controlled by a regulatory sequence of DNA and when this regulatory sequence is activated it controls the development of the ears and also inhibits branching in the plant. The DNA sequence in the tb1 gene is just about identical in *teosinte* and modern maize. In modern maize the gene is expressed in high levels in every axillary bud, resulting in inhibition of branching, whereas in *teosinte* it is expressed in low levels, so many branches form. The diagrams below show modern maize and *teosinte.*




**f** Suggest how a difference in the expression of the tb1 gene has occurred in modern maize.

_____

_____

_____

(1 mark)

Mexican Indians were the first people to domesticate modern maize from the wild *teosinte* plant between eight and ten thousand years ago.

**g** Name the process that resulted in the domestication of modern maize.

_____

(1 mark)

**h** Using the tb1 gene as an example, outline the steps that these ancient Mexican Indians would have used to achieve such domestication.

_____

_____

_____

_____

_____

(3 marks)

**Total 12 marks**

**Question 5**

Alpha-1-antitrypsin (AAT) is a glycoprotein produced by the liver that protects the lungs by stimulating an enzyme that clears away dead tissue and keeps the lungs functioning. An inherited disorder resulting in a deficiency of AAT leads to chronic tissue breakdown in the lungs. The gene for AAT is on the long arm of chromosome 14. There are several alleles for this gene denoted by M, S and Z. The table below shows the percentage of AAT in the blood of individuals with the various genotypes.

| Genotype | % of normal levels of AAT |
|---|---|
| MM | 100 |
| MS | 80 |
| SS | 60 |
| MZ | 60 |
| SZ | 40 |
| ZZ | 13 |

**a** What is the mode of inheritance of AAT deficiency? Explain your answer.

_____

_____

(2 marks)

For people who have this deficiency, AAT is usually extracted from human blood and given to them. However, only very small quantities are obtained. Scientists now use genetic engineering techniques to obtain AAT. Sheep have been chosen to produce AAT in their milk and the procedure is outlined below.

- Mature eggs are collected from sheep and fertilised in vitro.
- A plasmid is prepared that contains the AAT gene and a milk regulator gene that causes the AAT gene to be expressed in the udders of the sheep.
- The plasmids are microinjected into the fertilised eggs.
- The embryos are implanted into surrogate ewes.
- Female offspring are tested to see if their milk contains AAT.

**b** What term is given to these female offspring that produce AAT?

_____

(1 mark)

**c** What is the function of the plasmid?

_____

(1 mark)

**d** What part of the zygote cell would the plasmid be inserted into? Explain your answer.

_____

_____

_____

_____

(2 marks)

**e** Why is a mammal like a sheep chosen to produce AAT rather than a prokaryote cell such as bacteria?

_____

_____

(1 mark)

**Total 7 marks**

**Question 6**

The fossil remains of stone-age people were discovered in south-west China in 1989 but remained unstudied until 2008. A scientist called them the Red Deer Cave people after the area where they were found. They hunted ancient red deer, which they cooked and ate. These fossils were dated at approximately 11,000 years old. Modern humans were known to live immediately east and south of these Red Deer Cave people.

**Modern *Homo sapiens* skull**

**Red Deer Cave fossil skull**

**a** Explain how the age of these fossils would have been determined.

_____

_____

(1 mark)

**b** Give two ways in which the Red Deer Cave fossil skull differs from the modern human skull.

_____

_____

(2 marks)

The Red Deer Cave fossils had modern looking frontal lobes to their brains but the parietal lobes at the top of the head were short and primitive. Many theories were put forward to explain these features. Some scientists thought that these characteristics may be due to genetic drift.

**c** What is genetic drift?

_____

(1 mark)

Another theory was that the Red Deer Cave people could have mated with other primitive forms of hominins that were around at the time, such as Neanderthals.

**d** How might scientists attempt to investigate this theory?

_____

_____

(1 mark)

**e** Explain why this investigation could prove to be difficult.

_____

_____

(1 mark)

Loss of body hair in our ancestors occurred first in *Homo erectus*. One advantage of less hair is fewer parasites such as fleas and lice.

**f** Give another advantage of less body hair for these hominins.

_____

_____

(1 mark)

There are two distinct species of lice that infect humans. The head louse *Pediculus humanus* and the pubic louse, *Phthirus pubis.* The evolutionary history of the primates is shown below in diagram 1 and the corresponding history of the lice that parasitise them in diagram 2.

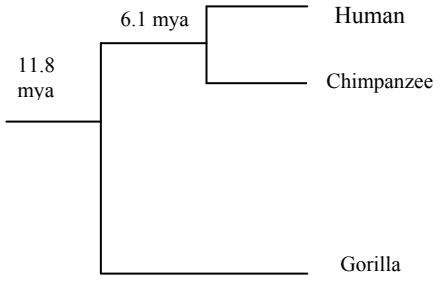



Diagram 1

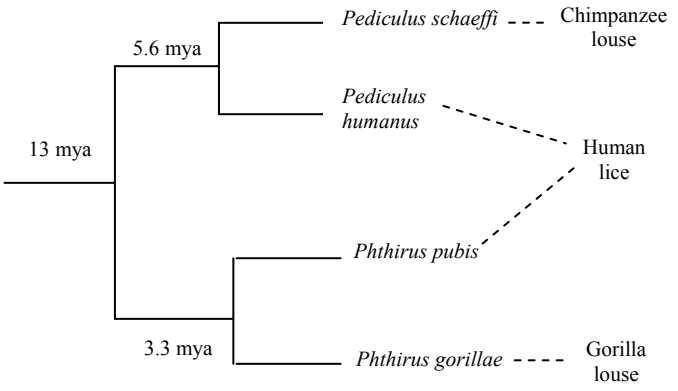



Diagram 2

This is an example of co-evolution.

**g** Explain what is meant by co-evolution by referring to the diagrams above.

_____

_____

_____

(1 mark)

Scientists used a technique known as a molecular clock in order to estimate the evolutionary divergent times shown above.

**h** Outline how a molecular clock works.

_____

_____

_____

_____

_____

(2 marks)

One would expect humans to have only one louse species as the chimpanzee and the gorilla have.

**i** Using the diagrams above, explain how each of the species of lice came to infect humans.

**(i)** *Pediculus humanus*

_____

_____

_____

**(ii)** *Phthirus pubis*

_____

_____

_____

_____

_____

(1 + 2 = 3 marks)

**Total 13 marks**

**END OF EXAMINATION**

**Acknowledgements: Websites**
http://train-srv.manipalu.com/wpress/?p=129420
http://en.wikipedia.org/wiki/File:Translocation-4-20.png
http://gardener.wikia.com/wiki/Capsicum_annuum_'Bell'
biodidac.bio.uottawa.ca/thumbnails/catquery.htm?...
http://wyrdscience.wordpress.com/tag/glossopteris/
http://teosinte.wisc.edu/morphology.html
http://haysvillelibrary.wordpress.com/2009/05/07/
http://www.whatsonxiamen.com/news24195.html
http://www.science3point0.com/genegeek/2010/12/13/mixed-up-chromosomes