STAV Publishing 2008

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	7	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, mobile phones and/or any other unauthorised electronic devices.
- 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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Phone: 61 + 3 9385 3999 • Fax: 61 + 3 9386 6722 • Email: stav@stav.vic.edu.au Website: http://www.sciencevictoria.com.au/stavpublishing/

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STAV Publishing

2008

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

Instructions for Section A

Answer all questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.

Question 1

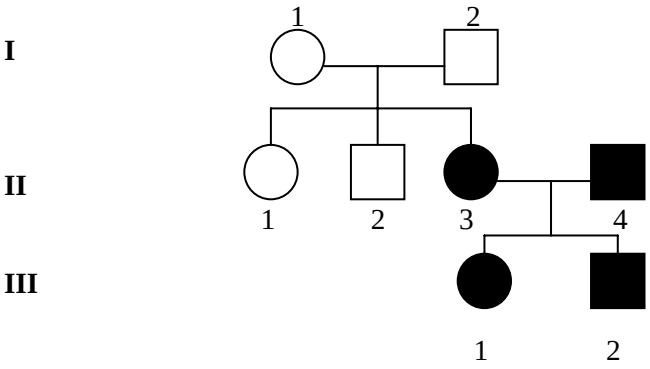
Offspring from the cross below could produce:

AaBb x aabb

A. four different phenotypes with four different genotypes.
B. four different phenotypes with two different genotypes.
C. two different phenotypes with four different genotypes.
D. two different phenotypes with two different genotypes.

Question 2

In the pedigree below the shaded individuals have the trait under investigation.



The mode of inheritance of this trait would be:

A. autosomal recessive.
B. autosomal dominant.
C. X-linked dominant.
D. X-linked recessive.

Question 3

A man has hypertrichosis or hairy ears. This is due to a gene on the non-homologous part of the Y chromosome. He marries a woman who has normal ears. It is reasonable to expect that:

A. all children born to this couple will show the hairy ear trait.
B. all boys born to this couple will show the hairy ear trait and none of the girls.
C. all the girls born to this couple will show the hairy ear trait and none of the boys.
D. the chance any boy born to this couple having the hairy ear trait is ½ .

Question 4

In humans the gene influencing blood grouping has three different alleles.
They are:

$\mathbf{I^A}$
$\mathbf{I^B}$
i

Based on these alleles, humans can have the following blood groups:

Group A
Group B
Group AB
Group O

A man who is blood group A marries a woman who is blood group B.
It reasonable to state that:

A. they could have 4 children who are blood groups A, B, AB and O.
B. they can only have children who are blood group AB as the A and B alleles are codominant.
C. they can only have children who are either blood group A or blood group B as the parents are groups A and B.
D. they can never have children who are blood group O as O is recessive and neither parent is group O.

Question 5

A single strand of DNA is 3' TACCGAGTAC 5'. It is reasonable to state that the mRNA chain that would be made from this strand would be:

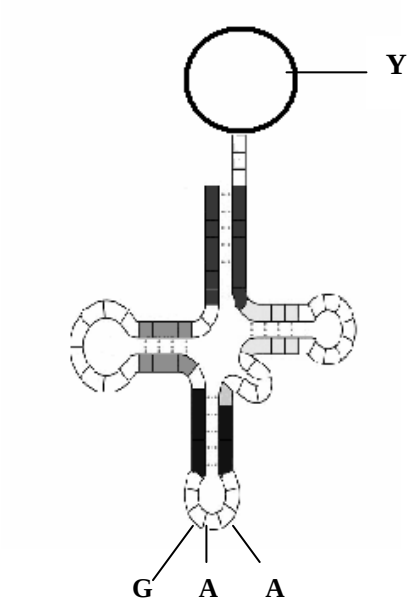
A. 3' TACCGAGTAC 5'
B. 5' ATGGCTCATG 3'
C. 5' AUGGCUCAUG 3'
D. 3' GUACUCGGUA 5'

Question 6

Human chromosomes show a wide range in size, from the Y chromosome that is the smallest, to chromosome number one that is the largest. The size of the chromosomes is determined by:

A. the number of DNA molecules in each chromosome.
B. the length of the DNA molecules in each chromosome.
C. the amount of protein associated with each chromosome.
D. the amount of coiling of the DNA molecule in each chromosome.

Questions 7 and 8 refer to the following diagram.



Question 7

The molecule represented in the diagram above is found in the cytosol of the cell.
The molecule represented is:

A. tRNA and **Y** represents a specific amino acid.
B. tRNA and **Y** represents a ribosome.
C. mRNA and **Y** represents a ribosome.
D. a ribosome and **Y** represents mRNA

Question 8

The DNA base sequence corresponding to the bases GAA shown in the diagram above would be:

A. CUU
B. CTT
C. GAA
D. TCC

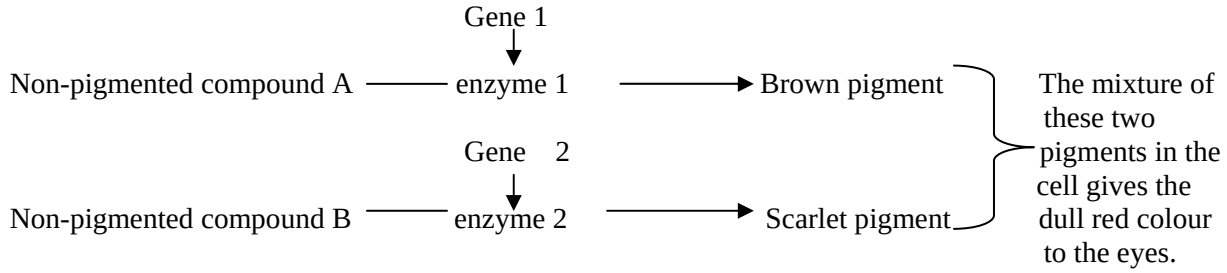
Question 9

The rabbage (*Raphanobrassica sp.)* is a diploid hybrid scientists developed from a cross between the radish (*Raphanus sp.*) and the cabbage (*Brassica sp.*). Both the radish and the cabbage have a haploid number of 9. Further experiments resulted in a tetraploid hybrid of the rabbage.
It would be reasonable to expect that:

A. both the tetraploid and the diploid hybrids would be fertile as both have an even number of chromosomes.
B. both the tetraploid and the diploid hybrids would be sterile as the cabbage and the radish are two different species.
C. the diploid hybrid would be fertile as it can form gametes with 9 chromosomes like the original parents, but the tetraploid would be sterile as it would have to form gametes with 18 chromosomes and this is different from the original parents.
D. the diploid hybrid would be sterile as the two sets of chromosomes are not homologous pairs, whereas the tetraploid would be fertile as the doubling of the chromosomes results in homologous pairs.

Question 10

The dull red colour of the eyes of wild type flies is due to a mixture of two kinds of pigment. These pigments are produced by the action of enzymes, genetically determined, on non-pigmented compounds as shown in the flow diagram below.



The alleles for gene 1 are G_1 and g_1. The alleles for gene 2 are G_2 and g_2. The alleles g_1 and g_2 are unable to produce functional enzymes. If a fly cannot produce both enzyme 1 and enzyme 2 it will end up with white eyes. If only one pigment is formed the eyes will be that colour.
Based on the information:

A. a fly with genotype g_1g_1 and G_2g_2 will have brown eyes.
B. a fly with genotype G_1g_1 and G_2g_2 will have white eyes.
C. a fly with genotype G_1G_1 and g_2g_2 will have dull red eyes.
D. a fly with genotype G_1G_1 and G_2g_2 will have dull red eyes.

Question 11

The expression of both alleles at a particular locus producing two different phenotypes in the same individual is an example of:

A. polygenes.
B. incomplete dominance.
C. co-dominance.
D. continuous variation.

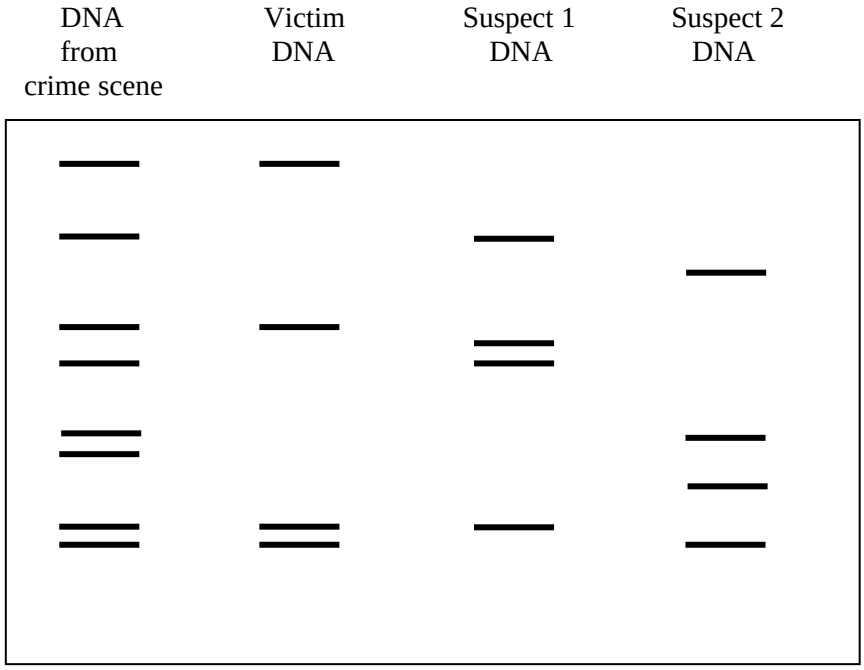
Question 12

Colour in wheat plants is determined by genes on separate chromosomes. When dark red wheat plants are crossed with white varieties the F_1 generation produced is "light red". When the F_1 generation are crossed the F_2 generation produced has a wide range of colours – dark red, medium red, light red, pink and white. This evidence would suggest that colour in wheat plants is:

A. a polygenetic trait as the phenotypes show discontinuous variation.
B. a polymorphic trait as 5 separate phenotypes are shown.
C. a polygenetic trait as the phenotypes show a continuous variation.
D. a multiple allelic trait as there are 2 pairs of alleles contributing to the colour.

Question 13

DNA profiling has become an important tool in forensic investigations. DNA collected at the crime scene can be used to compare with DNA of the victim and suspects. The diagram below represents a gel electrophoresis run of DNA found at the crime scene, DNA from the victim and DNA from 2 suspects.



Based on this forensic evidence:

A. only suspect 1 left DNA at the crime scene.
B. only suspect 2 left DNA at the crime scene.
C. both suspects 1 and 2 left DNA at the crime scene.
D. neither suspect 1 nor suspect 2 left any DNA at the crime scene.

Question 14

Transcription is the process of copying the genetic instructions from the nuclear DNA. The enzyme involved in this process is:

A. DNA polymerase
B. RNA polymerase
C. reverse transcriptase
D. DNA ligase

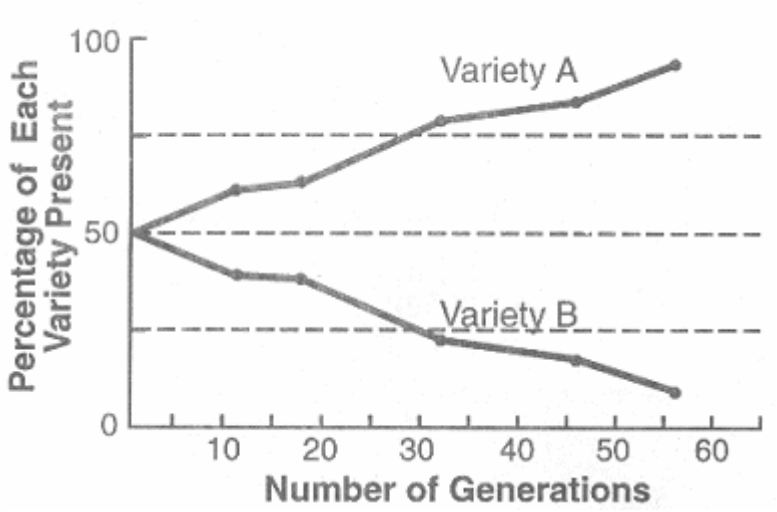
Question 15

The northern elephant seal (*Mirougnga angustirostris)* was hunted almost to extinction in the 1890's. Their population size was reduced to only 20 individuals by the end of the 19th century. The population is now over 100,000 due to protection from hunting. This current population would:

A. show an increase in genetic diversity because the numbers have recovered and there is more random mating.
B. show a loss of genetic diversity due to genetic drift caused by bottlenecking.
C. show a loss of genetic diversity due to gene flow caused by the population suddenly increasing.
D. show an increase in genetic fitness as only those seals that were genetically fit would have survived the bottleneck.

Question 16

The change in percentage of varieties A and B in a particular plant species over a number of generations is shown in the graph below.



The data indicates that:

A. variety A is unable to mate with variety B.
B. varieties A and B, being the same species, would be genetically identical.
C. variety A has an adaptive advantage in this particular environment not shown by variety B.
D. variety B will be extinct by the 60th generation.

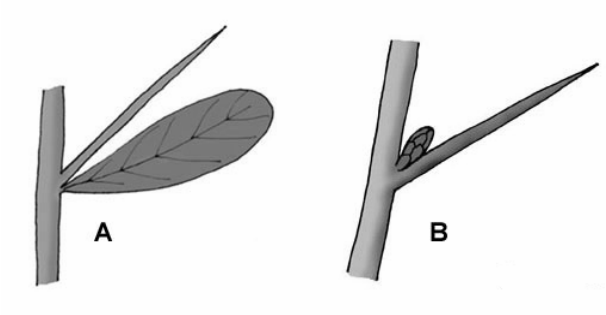
Question 17

A company developed a new insecticide and used it to kill disease-causing mosquitoes. The spraying was very successful, eliminating large populations of the mosquitoes. After several years the insecticide gradually became less effective and the numbers of mosquitoes started to increase. A reasonable explanation for this observation was that:

A. the insecticide is a mutagen causing resistant mutations in the mosquito genome.
B. resistant mosquitoes from other populations moved into the area to occupy the niche left by the dead mosquitoes.
C. some mosquitoes in the original population were genetically resistant to the insecticide and passed this resistance down to their offspring.
D. insects naturally become resistant to insecticide when it is used over a long period of time.

Question 18

Many different plants have spines, as shown in diagram A below, or thorns, as shown in diagram B for protection against browsing animals. Spines have evolved from leaves and thorns have evolved from stems of ancestral plants.



These protective structures are examples of:

A. convergent evolution and are analogous structures.
B. divergent evolution and are homologous structures.
C. convergent evolution and are homologous structures.
D. divergent evolution and are analogous structures.

Question 19

In 1775 a devastating typhoon reduced the human population of the island of Pingelap in Micronesia to only 20 inhabitants. After a few generations the prevalence of the condition achromatopia (the inability to see colour) was 5% of the population and 30% of the population were carriers of the condition. This compares with a frequency of only 0.003% in a population like Australia. It is reasonable to state that:

A. this is an example of natural selection as achromatopia has a selective advantage on these islands.
B. this is an example of gene flow.
C. this is an example of the founder effect.
D. this is an example of the start of speciation.

Question 20

Horizontal gene transfer is common among bacteria, even those that are distantly related. Different species of bacteria occupying the intestine can quickly exchange DNA, especially antibiotic resistance, from one to another. It is reasonable to state that the bacterial cells that have received the antibiotic resistant gene from other bacteria in the gut are:

A. genetically modified organisms.
B. said to be transformed.
C. said to be transfected.
D. said to be translocated.

Question 21

The study of human evolution has involved the study of mitochondrial DNA. Mitochondrial DNA is useful because:

A. it is inherited over thousands of generations without crossing over and exchanging genetic material with other mitchondrial DNA.
B. it has more genes than nuclear DNA.
C. it is present in sperm as a source of energy for movement, so it is inherited down the male line.
D. it is a single short linear molecule that is easy to amplify.

Question 22

Scientists have found crafted lumps of pigment, essentially crayons, left behind by Neanderthals across Europe. Neanderthals used these crayons to mark their bodies in a form of body painting. It is reasonable to conclude that:

A. this is an example of biological evolution as the Neanderthal's opposable thumb has evolved as a characteristic of the primates.
B. this is an example of cultural evolution that would have only been possible after the biological evolution of the opposable thumb.
C. this is not an example of cultural evolution as body paint would not stay on the body long enough for the concept to be passed down.
D. this is not an example of cultural evolution as Neanderthals could not communicate to pass this information on.

Question 23

Bipedalism was an important evolutionary step in the evolution of human beings. One possible explanation for the evolution of bipedalism is that:

A. bipedalism enabled early human ancestors to run faster and escape predation.
B. bipedalism enabled the hands to be free to carry tools, food or young.
C. bipedalism is more efficient over short distances and less efficient over long distances, and early human ancestors only travelled short distances.
D. bipedalism resulted in the development of longer legs and shorter arms.

Question 24

The use of somatic and embryonic stem cell technology to replace damaged cells in individuals is an important area of medical research. Concerning this area of research it is reasonable to state that:

A. the use of embryonic stem cells has the advantage over somatic stem cells in being pluripotent.
B. the use of somatic stem cells has the advantage over embryonic stem cells of being more readily available as they can be extracted from all adult tissues.
C. somatic stem cells are created by removing a nucleus from an egg cell and replacing it with a nucleus from a somatic cell, thus giving it the potential to develop into any type of cell.
D. both embryonic stem cells and somatic stem cells can both divide indefinitely but can only become the cells that they have been programmed to become.

Question 25

Gene therapy is the introduction into a tissue, usually by means of a viral vector, of a specific piece of DNA to replace a defective allele. This procedure is often not successful because:

A. the virus vector can mutate into a virulent strain and reproduce in the tissue fluid.
B. this treatment is only suitable for dominant alleles such as Huntington's Disease.
C. the piece of DNA may be inserted into an existing gene resulting in this gene not being able to function.
D. the ability of the individual to pass the new allele down to offspring is not always effective.

END OF SECTION A

SECTION B - Short Answer Questions

Instructions for Section B

Answer this section in pen.
Answer all questions in the spaces provided.

Question 1

Melandrium album is a species of plant that has separate male and female plants. The male plants, like mammals, have sex chromosomes X and Y and the female plants have sex chromosomes XX. An X-linked gene governs leaf size in this species.
The gene for leaf size has two alleles:

B : broad leaves
b : narrow leaves

a How many alleles are there for leaf size in the somatic cells of a male plant?

_____

(1 mark)

Pollen grains carrying the recessive allele of this plant are not viable. A heterozygous broad-leafed female plant is crossed with a narrow leafed male plant.

b What are the genotypes of the ovules produced by this plant with respect to this gene?

_____

(1 mark)

c What are the possible phenotypes and genotypes of the offspring? Show all your working and **explain** the results you obtained.

_____

_____

_____

_____

_____

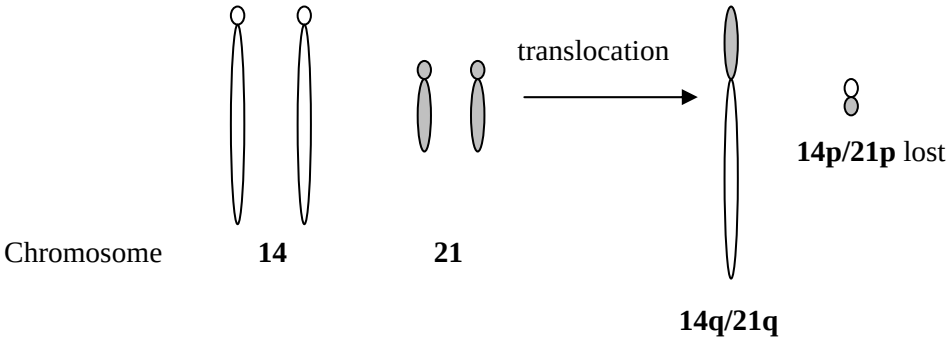
_____

(3 marks)

Total 5 marks

Question 2

Sometimes structural abnormalities in the chromosomes leads to inherited conditions in humans. If a section of a chromosome breaks off and attaches to another non-homologous chromosome this is called a Robertsonian translocation. The long arm of chromosome 21, the **q** arm, can become detached and attach to the long arm of chromosome 14 as shown in the diagram below. The two short arms of these chromosomes (the **p** arms) are lost. These **p** arms code mainly for ribosomal RNA and these genes are found in other parts of the genome. The translocation together with the loss of these sections of chromosomes (the **p** arms) does not affect the functioning of the individual. This is called a balanced Robertsonian translocation.



a What would be the total number of chromosomes of a human with this translocation?

_____

(1 mark)

b Why are these people phenotypically normal?

_____

_____

(1 mark)

A woman with a translocation of chromosome 14 and 21 marries a man who is normal for chromosomes 14 and 21.

c Using the diagram above as a basis, draw all the possible gametes of the mother in the space below.

(2 marks)

Fertilised eggs that end up with what is effectively 3 of chromosome 21 develop into individuals with Robertsonian Down Syndrome. Fertilised eggs that end up with only one copy of chromosome 21 or 14 do not survive.

d In the space below draw the chromosomes of offspring of this couple that are capable of survival and state their phenotype.

(3 marks)

Total 7 marks

Question 3

When the DNA of a cell is damaged by toxic chemicals or UV light, a tumour suppressor gene called TP53, on chromosome 17, is activated to produce a protein p53. This protein is a transcription factor, binding to specific parts of the DNA to initiate transcription of certain genes.

a What is transcription?

_____

_____

(1 mark)

These genes when activated produce DNA repair proteins. This is an example of gene regulation.

b Why do genes need to be regulated?

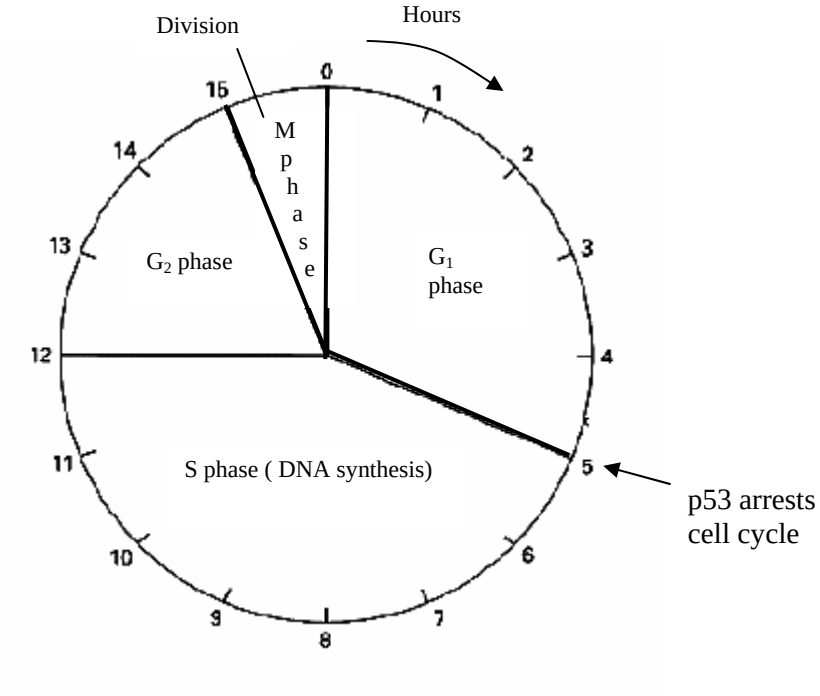
_____

_____

_____

(1 mark)

The p53 protein holds the cell cycle of the damaged cell at G_1/S as shown in the diagram below.



c Why would the cell cycle be held at this point?

_____

_____

_____

(1 mark)

Sometimes the DNA is unable to be repaired and the p53 protein initiates programmed cell death.

d What term is given to programmed cell death?

_____

(1 mark)

e Outline the events that occur during programmed cell death of a cell.

_____

_____

_____

_____

_____

_____

_____

(3 marks)

f Why is it important that cells containing irreversibly damaged DNA undergo programmed cell death?

_____

_____

_____

(1 mark)

Total 8 marks

Question 4

The common garter snake, *Thamnophis sirtalis*, is the only snake able to feed on poisonous newts of the genus Tarcha. The newts have continued to develop stronger toxins and the garter snakes have developed more resistance to the toxins in response. This is seen in certain areas referred to as evolutionary hotspots.

a Name the type of evolution depicted above between the garter snake and the newt.

_____

(1 mark)

b Outline the steps that would have led to the evolution of newts with extremely poisonous toxins.

_____

_____

_____

_____

_____

(2 marks)

c What is the selective agent associated with increase in toxin strength?

_____

(1 mark)

Studies of snake populations with high levels of resistance to the newt toxin show that these snakes move more slowly than snakes with lower resistance and these same snakes can often be incapacitated for a short time after ingesting a poisonous newt.

d Suggest a problem for these snakes in view of this data.

_____

_____

(1 mark)

Snakes with very high levels of resistance and newts with high toxicity levels are found only in certain areas called hot spots.

e Suggest one factor that would increase the chances of these hot spots occurring.

_____

_____

_____

_____

(1 mark)

Total 6 marks

Question 5

A long standing theory that whales are closely related to hippopotami has been supported by a 47 million year old fossil found in Pakistan named *Rodhecetus.*

Rodhecetus

The complete restoration of the fossil showed that the front feet retained hoofs and the hind feet had webbed toes.

a What does this information tend to indicate about the habitat of *Rodhecetus*?

_____

(1 mark)

The fossil of *Rodhecetus* is the first known specimen that combines ankle bones from a sheep-like creature and skull bones from an ancient whale in the same skeleton.

b In view of this statement what type of fossil would *Rodhecetus* be?

_____

(1 mark)

Earlier, scientists originally thought hippopotami were more closely related to pigs.

c On what basis would scientists have placed hippopotami and pigs in a close relationship?

_____

(1 mark)

Scientists are able to compare the DNA sequences in particular genes, in different species, in order to determine evolutionary relationships.

d Suggest a problem associated in inferring evolutionary relationships using the technique of DNA sequencing in particular genes.

_____

_____

(1 mark)

e How might scientists reduce this problem?

_____

_____

(1 mark)

The relationship between hippopotami and whales has been further supported by examining the DNA of these animals that does not code for proteins. Some of this so called "junk DNA" can copy itself and then splice these copies back into the main DNA strands at specific points. These short interspersed elements or SINES once inserted stay there. The insertion of a SINE at a particular location does not appear to happen independently. Researchers look at particular examples of these SINES at specific sites in the genome of different species in order to determine relatedness between species.

f How is the examination of SINE sites more reliable than the technique of DNA sequencing for a particular gene?

_____

_____

(1 mark)

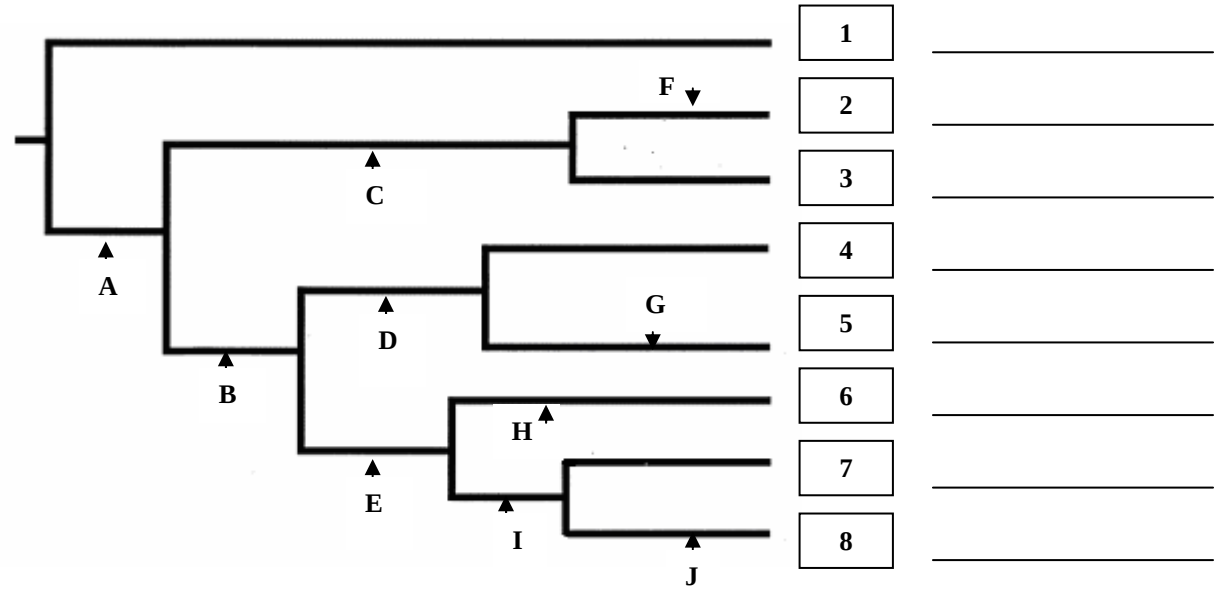
The cladogram shown below has been drawn as a result of SINE sites in the related species –

Toothed whales
Baleen whales
Peccaries
Camel
Hippopotami
Chevrotains
Pigs
Pecorans

Particular SINEs are represented on the cladogram by letters A to J. The arrows mean that all species to the right of the arrows have that particular SINE.
The table below shows the animals from the list above that have the particular SINE.

SINE	Species with the SINE
A	All species except the camel
B	All species except the camel, pigs and peccaries
C	Only pigs and peccaries
D	Only pecorans and Chevrotains
E	Only toothed whales, hippopotami and baleen whales
F	Only pigs
G	Only pecorans
H	Only hippopotami
I	Only toothed whales and baleen whales
J	Only baleen whales

g Use the information above to write the animal names against the appropriate number.

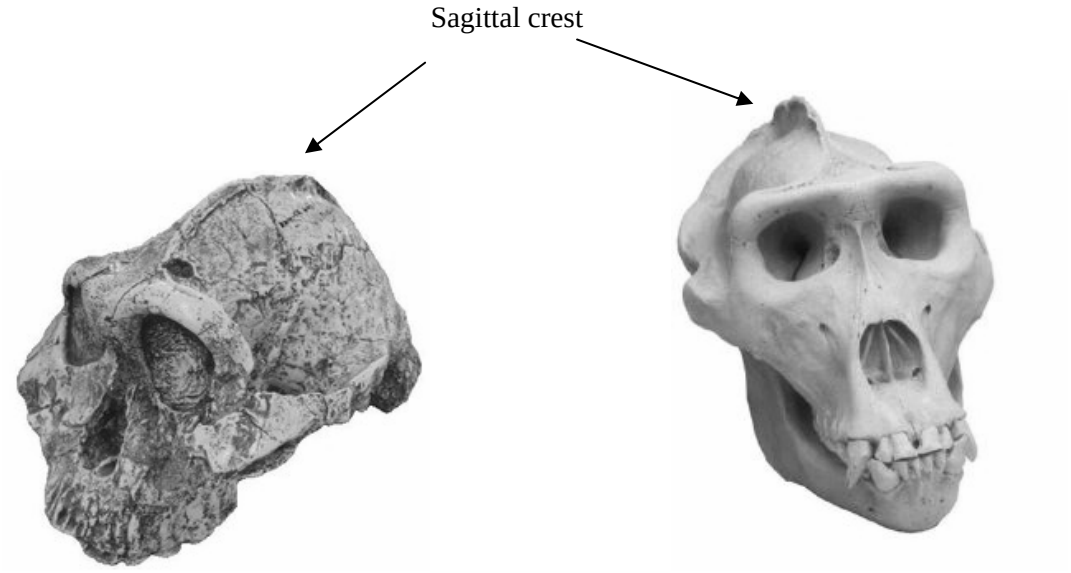


(2 marks)

Total 8 marks

Question 6

Paranthopus robustus, an early hominin, lived between 2.7 and 1.2 million years ago. This early hominin was bipedal. Members of the genus *Homo*, such as *Homo habilis* existed at the same time as *P.robustus.* The sagittal crest is a ridge of bone running lengthwise along the midline of the skull. This is very pronounced in the gorilla and *P. robustus* shown below. The crest facilitates the attachment of large jaw muscles. These early hominins also had very large molar teeth.



Early hominin – *Paranthopus robustus* Modern day gorilla - *Gorilla gorilla*

a What would this information tend to suggest about the diet of *P robustus*? Explain your answer.

_____

_____

_____

_____

(2 marks)

b Name **two** features, other than the sagittal crest, that would distinguish the genus *Homo* from other early hominins such as *P. robustus.*

_____

(2 marks)

c Outline how **one** of these features would have had a selective advantage for the genus *Homo*.

_____

_____

_____

_____

_____

(1 mark)

Total 6 marks

Question 7

For the last 10,000 years human beings have modified the traits of plants by means of selective breeding.

a What is selective breeding?

_____

_____

(1 mark)

The production of cultivars (domesticated varieties of plants) from wild types has often been referred to as a kind of genetic bottleneck.

b Explain what is meant by this observation.

_____

_____

_____

(1 mark)

Scientists have developed a technique based on the principles of selective breeding but also using modern gene technology. This involves using particular DNA markers to enable scientists to select the gene of interest. This technique is called “smart breeding” or Marker Assisted Selection (MAS).

c What is a genetic marker?

_____

_____

(1 mark)

d Why use a marker instead of trying to isolate the gene of interest itself?

_____

_____

(1 mark)

Ideally the genetic marker should be as close to the gene of interest as possible.

e Explain why the genetic marker should be as close to the gene of interest as possible.

_____

_____

_____

(1 mark)

The process of MAS involves the following steps:

- Leaf tissue is grown for DNA isolation
- DNA is extracted from the plant tissue and cut
- PCR and gel electrophoresis are performed
- The plants that show the marker and the desired gene are identified
- These plants are back-crossed with the original wild types to remove any undesirable genes

f Outline the steps in the PCR procedure.

_____

_____

_____

_____

_____

(2 marks)

g What means is used in biotechnology to cut DNA?

_____

(1 mark)

There has been a lot of controversy surrounding the use of genetically modified organisms, especially those that are food crops.

h How does the use of MAS to produce desirable traits in crops differ from the formation of a genetically engineered organism and how is this therefore make it more likely to be acceptable to the public?

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_____

(2 marks)

Total 10 marks

END OF EXAMINATION

Acknowledgements
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