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STAV Publishing 2009

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.
- No calculator is allowed in this examination.

Materials supplied

- Question and answer book of 23 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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STAV Publishing

2009

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 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, 2 and 3 refer to the following human karyotype .

Question 1

The karyotype above is abnormal because:

A. there is no homologous partner for the Y chromosome.
B. there are 47 autosomes instead of 46.
C. there are two X chromosomes as well as a Y chromosome.
D. the chromosomes should all be the same size.

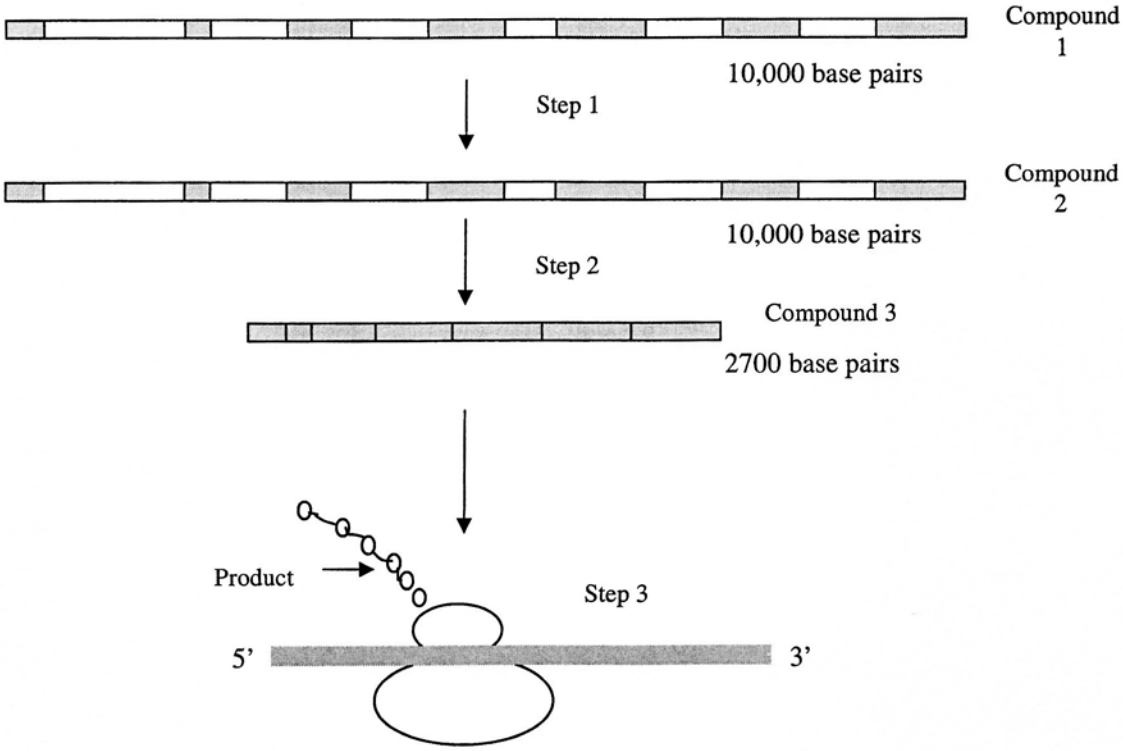
Question 2

The most likely cause of this abnormality is:

A. non-disjunction in the formation of an egg in the female parent only.
B. non-disjunction in the formation of a sperm in the male parent only.
C. non-disjunction in the formation of an egg in the female parent or sperm in the male parent
D. non-disjunction in the first cell division of the newly formed zygote.

Questions 6, 7 and 8 refer to the following information.

The following diagram outlines the steps from gene to gene product.



Question 6

Step 2 in the above diagram represents:

A. removal of introns.
B. translation.
C. removal of exons.
D. transcription.

Question 7

It is reasonable to state that:

A. steps 1 and 2 occur in the nucleus whereas step 3 occurs in the cytosol.
B. step 1, 2 and 3 all occur in the nucleus.
C. the product formed consists of 2700 amino acids.
D. the units of the product are held together by hydrogen bonds.

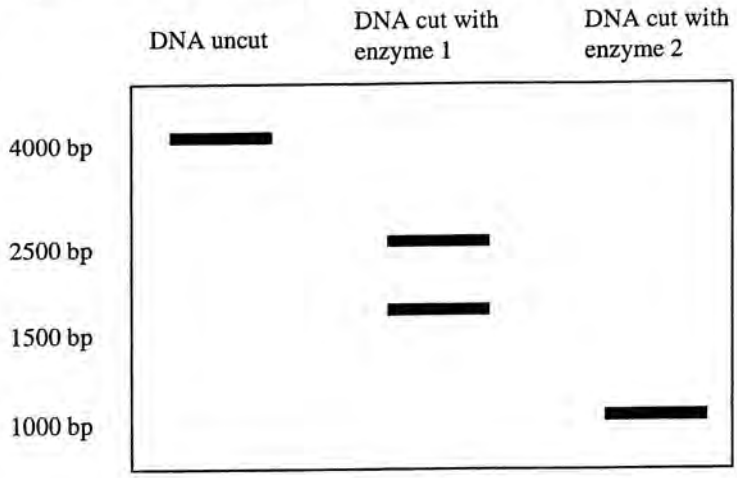
Question 8

It is reasonable to state that step 1 would:

A. involve adenine in DNA binding to thymine in mRNA .
B. produce a product, compound 2, which is identical to compound 1.
C. involve a section of DNA unwinding due to the breaking of hydrogen bonds.
D. involve the action of the enzyme DNA polymerase.

Question 9

A linear piece of DNA is cut by two different restriction enzymes and then run on an electrophoresis gel. The bands shown on the electrophoresis gel below are from an uncut piece of DNA, this same piece of DNA cut by enzyme 1 and the same piece of DNA cut by enzyme 2.

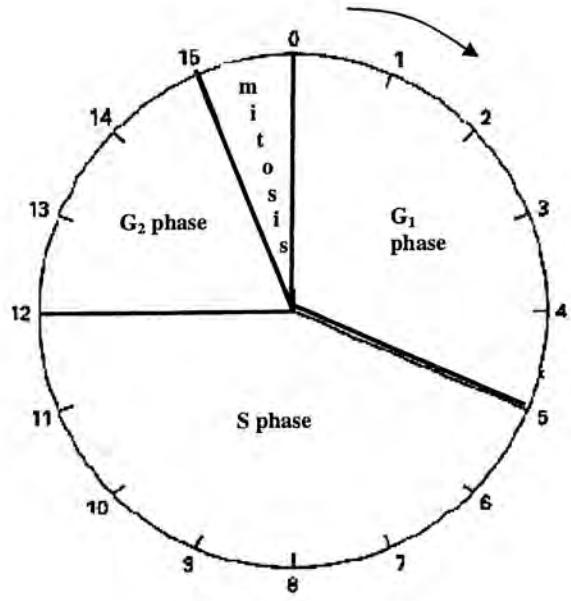


From this gel it can be concluded that:

A. Enzyme 1 cuts at two sites and enzyme 2 cuts at one site.
B. Enzyme 1 cuts at one site and enzyme 2 cuts at three sites.
C. Enzyme 1 cuts at three sites and enzyme 2 cuts at one site.
D. Enzyme 1 cuts at two sites and enzyme 2 cuts at three sites

Question 10

The following diagram shows the series of events when a cell replicates. The arrow indicates the direction of the cycle.



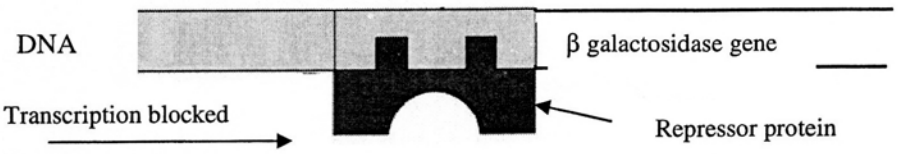
A biologist was measuring the amount of DNA in cells growing in a laboratory. The amount of DNA would be seen to double during:

A. the G_1 phase.
B. the G_2 phase.
C. the mitosis phase.
D. the S phase.

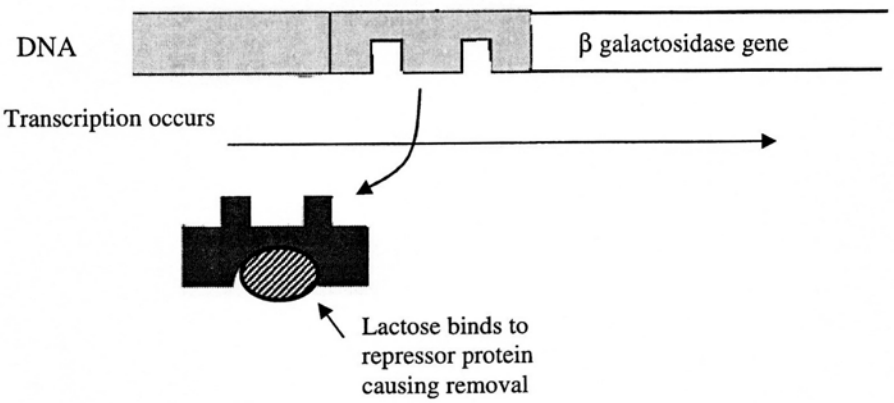
Questions 11 and 12 refer to the following information.

In the bacteria, *Escherichia coli,* a protein repressor molecule attaches to the DNA and prevents transcription of the gene for the formation of the enzyme β galactosidase whose function it is to break down the sugar lactose. When lactose is present, it binds to this repressor protein, which causes it to be removed from the DNA, enabling the production of the enzyme β galactosidase.

When lactose is not present



When lactose is present



Question 11

The control represented in the diagram is:

A. gene conservation.
B. gene regulation.
C. gene engineering.
D. genetic counselling.

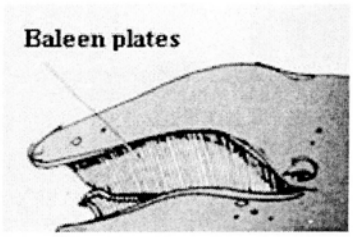
Question 12

The enzyme prevented from functioning when the protein repressor molecule attaches to the DNA would be:

A. β galactosidase.
B. DNA polymerase.
C. RNA polymerase.
D. RNA interferase.

Question 13

Certain species of whales possess baleen instead of teeth. The baleen acts as a filter, enabling the whale to take in plankton from seawater. As baleen whales develop, the whale embryo at a certain stage of development possesses teeth. These teeth are replaced by baleen before birth.

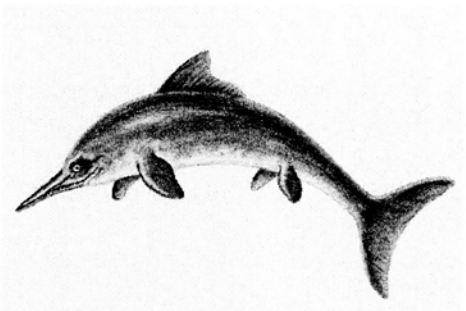


The possession of teeth by embryonic baleen whales is evidence that:

A. all whales have descended from terrestrial mammals.
B. baleen is a more primitive structure than teeth.
C. baleen whale embryos pass through a stage when they resemble adult toothed whales.
D. baleen whales have descended from toothed whales.

Question 14

Ichthyosaurs were aquatic dinosaurs. The fossil record shows that *ichthyosaurs* had dorsal fins and tail like a fish, even though their closest relatives were terrestrial reptiles looking like giant lizards.



It is reasonable to state that the dorsal fins of fish and *ichthyosaurs* are:

A. homologous structures.
B. an example of convergent evolution.
C. an indication that ichthyosaurs are closely related to fish.
D. an example of coevolution between fish and reptiles.

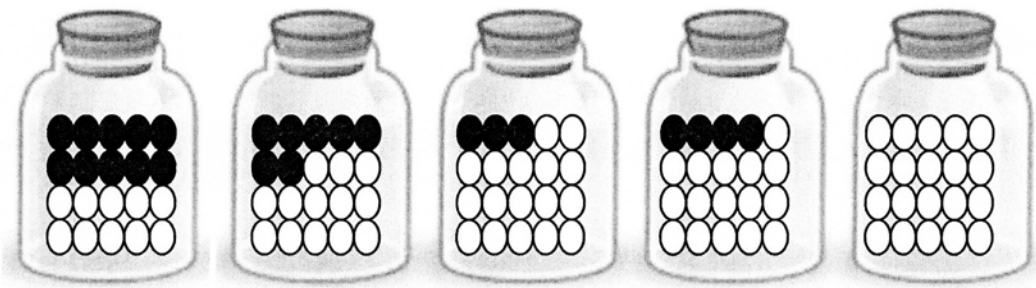
Question 15

DNA is found in all living organisms. It is reasonable to state that:

A. in prokaryotic cells DNA is found only in a specific number of linear chromosomes typical of the particular species.
B. in eukaryotic cells DNA is found only in a specific number of linear chromosomes typical of the species.
C. in eukaryotic cells DNA is found in both linear chromosomes and numerous plasmids.
D. in prokaryotic cells DNA is found in a circular chromosome and numerous plasmids.

Question 16

A student carried out the following modelling experiment. She took 20 beads, 10 each of two different colours and placed them in a jar. She then randomly selected a bead from the first jar, noted the colour, and deposited a bead of that same colour, from a stockpile of beads, into the next jar. She returned the first bead to the original jar and repeated the process 20 times until the second jar contained 20 beads. She repeated the process starting with the second jar. The results of the modelling experiment are shown below.



First generation second generation third generation fourth generation fifth generation

The experiment performed was intended to demonstrate:

A. genetic drift.
B. macroevolution.
C. dominant and recessive traits.
D. gene flow

Question 17

A scientist investigated several related species of organisms by examining the amino acids in 4 separate areas or domains of a particular enzyme that the species had in common. Mutations that modify the active site of the enzyme are more likely to be harmful than mutations that affect other areas of the enzyme. The following table shows the areas of the enzyme and the percentage of the amino acids that are the same in the same position.

Area	% of homologous amino acids
1	38
2	8
3	78
4	45

Based on this information, the area that is most likely to be the active site of the enzyme would be:

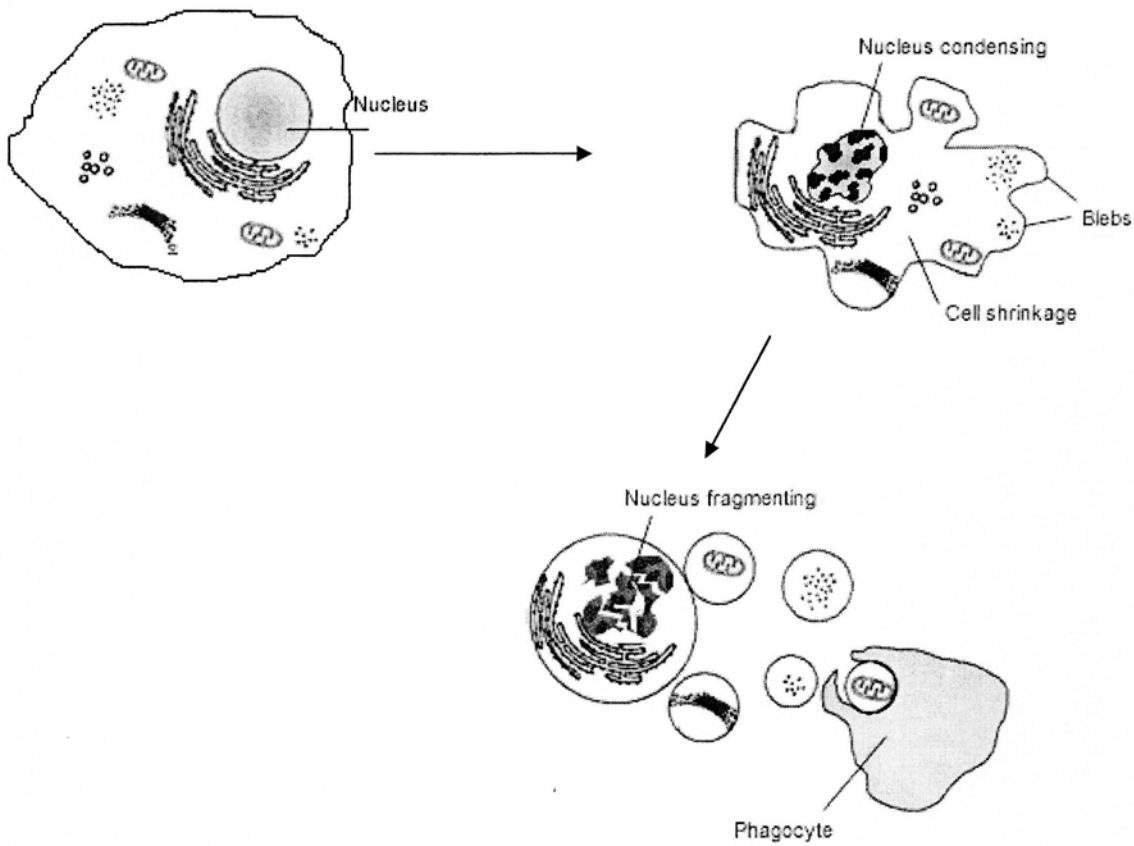
A. 1
B. 2
C. 3
D. 4

Question 18

Natural rubber or latex is produced by the tree *Hevea brasiliensis,* and is used for the production of heat resistant products such as tyres. Research has shown that the latex yield is controlled by 4 genes on different chromosomes, each gene consists of a contributing and noncontributing allele. The production of latex is an example of:

A. discontinuous variation.
B. directional selection.
C. polygenic inheritance.
D. linkage as all 4 genes contribute to the one phenotype.

Question 19

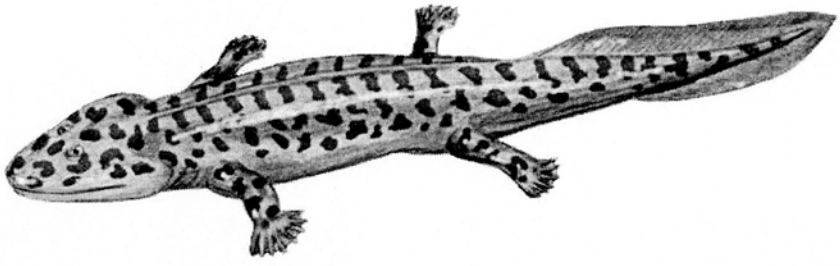


The process depicted in the series of diagrams above could be:

A. mitosis of cancer cells.
B. necrosis of damaged heart muscle cells.
C. binary fission of bacterial cells.
D. apoptosis of the outer layer of skin cells.

Question 20

Jennifer A. Clark, an English palaeontologist, and an expert in the science of evolution, discovered a fossil of an animal called *Acanthostega* in Greenland in1987. This organism lived 365 million years ago. Although water-bound, it possessed 4 legs, each with 8 webbed digits. It possessed lungs, although they could not function out of water. It had gills that were covered like a fish.



This fossil represents:

A. an index fossil.
B. a transition fossil.
C. an analogous fossil.
D. an indicator fossil.

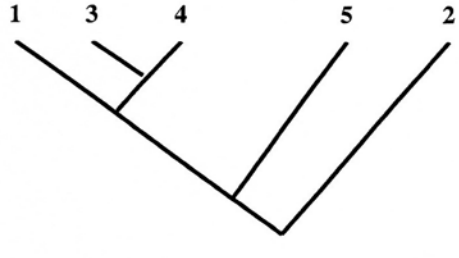
Question 21

Comparisons of the amino acid sequences of a section of a haemoglobin chain can be used to determine an evolutionary relationship between different organisms. The sequence of 4 amino acids in the same sequence of haemoglobin chain is shown in the table below.

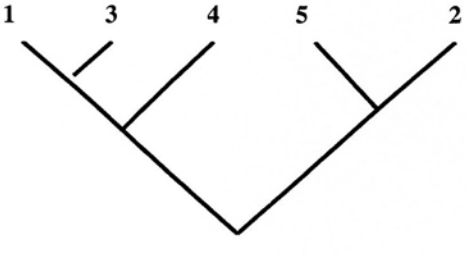
Organism	Number on diagram below	Amino acid sequence in a section of a haemoglobin chain
human	**1**	Lys- Glu-His-Phe
horse	**2**	Arg- Lys-His-Lys
chimpanzee	**3**	Lys- Glu-His-Phe
gorilla	**4**	Lys- Glu-His-Lys
zebra	**5**	Arg- Lys-His-Arg

Based on the information provided, the evolutionary tree that best represents the evolutionary relationship between these animals is:

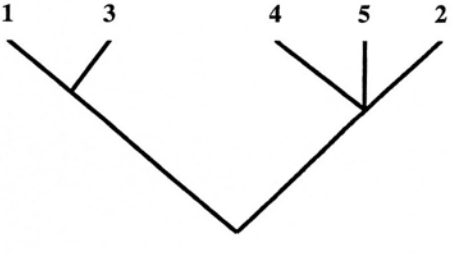
A.



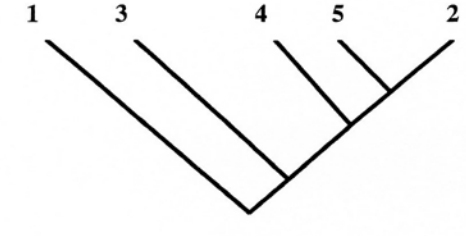
B.



C.

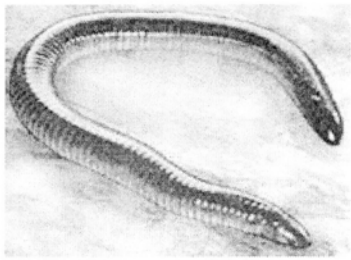


D.

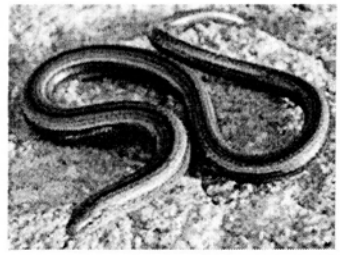


Question 22

Below are pictures of a limbless amphibian and a limbless lizard.



Limbless amphibian



Limbless lizard

The lack of legs in these vertebrates:

A. suggests that these animals are closely related.
B. is an example of homology.
C. is an example of divergence.
D. is an example of analogy.

Question 23

Trees of the genus *Adansonia*, of which the Australian boab tree is a member, occur in Africa, Madagascar, and the northern part of Western Australia and nowhere else in the world. This distribution is referred to as:

A. biogeography
B. biodiversity
C. genetic drift
D. geological distribution

Question 24

The cultural evolution of the genus *Homo* has been particularly rapid when compared to biological evolution. The most important contributor to cultural evolution has been:

A. the development of agriculture.
B. the use of tools to make artefacts.
C. the development of painting.
D. the development of articulate speech.

Question 25

Cystic fibrosis is a recessive condition that affects 1 in 2000 births. Trials on sufferers have involved attaching a cystic fibrosis normal gene to a small circle of DNA and trying to deliver it into cells lining the lungs of the patient.
The small circular piece of DNA containing the cystic fibrosis gene:

A. is called a plasmid.
B. will be passed on to the patient's offspring.
C. will be incorporated into the patient's genome, giving a permanent cure.
D. when incorporated into the lung cell is an example of making a genetically modified organism.

END OF SECTION A

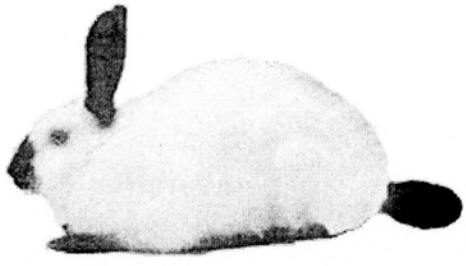
SECTION B - Short Answer Questions

Specific instructions for Section B

This section consists of 7 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

Himalayan rabbits have light coloured fur with dark extremities, such as the ears, nose, paws and tail. The dark extremities are caused by the recessive Himalayan allele (h). This gene is involved in the production of melanin. The dominant allele (H) produces full black pigmentation. Experimental evidence suggests that the enzyme produced by the Himalayan allele (h) is active only at low body temperatures. Therefore, the black fur only occurs at the extremities where the body heat is lower.



a Give the genotype of the Himalayan rabbit.

_____

(1 mark)

When Himalayan rabbits are born their fur is totally pale and the pigment only develops after they leave the nest.

b Explain why this is so.

_____

_____

_____

(1 mark)

c Outline an experiment that would enable scientists to decide that the enzyme produced by the Himalayan gene is only active at low temperatures.

_____

_____

_____

_____

_____

_____

(2 marks)

d What advantage would the Himalayan phenotype give the rabbit?

_____

_____

(1 mark)

Total 5 marks

Question 2

In guinea pigs the gene for hair length has the following alleles:

S : short hair s : long hair

On another chromosome there is another gene for hair colour. There are two codominant alleles governing this trait.

C^YC^Y gives a yellow colour
C^YC^W gives a cream colour
C^WC^W gives a white colour

a Explain the term codominant.

_____

_____

(1 mark)

A pure breeding longhaired yellow guinea pig was crossed with a pure breeding shorthaired white guinea pig.

b What is the genotype of these offspring?

_____

(1 mark)

Two of these offspring were then crossed.

c Draw up a punnet square to show this cross.

(3 marks)

d Use your punnet square to complete the table below with the theoretical phenotypes and their expected ratios.

Phenotypes	Ratios

(3 marks)

Total 8 marks

Question 3

Tay-Sachs disease is an autosomal recessive genetic disorder resulting in a mutation in the HEXA gene that produces the hexosaminidase enzyme responsible for the breakdown of GM2 gangliosides, fatty substances that need to be eliminated in the brain. One known mutation is a change at codon 180 where UAC is replaced by UAG.

a What type of mutation is represented here?

_____

(1 mark)

b Use the table provided below to determine what change results as a consequence of this mutation.

_____

_____

(1 mark)

C How will this change affect the individual?

_____

_____

_____

(1 mark)

The Genetic Code for mRNA codons to amino acids.

First Base Letter	Second base letter: U	Second base letter: C	Second base letter: A	Second base letter: G	Third Base Letter
U	Phenylalanine Phenylalanine Leucine Leucine	Serine Serine Serine Serine	Tyrosine Tyrosine ***Stop*** ***Stop***	Cysteine Cysteine ***Stop*** 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

Another mutation in the HEXA gene results in a 4 base insertion in exon 11. This mutation is found in a high percentage of the Cajun population in southern Louisiana in the United States. This is an American ethnic group that has been isolated due to language differences. When examining families carrying this mutation, researchers found that nearly all the families had a single French couple as a common ancestor.

d Explain how there could be such a high incidence of Tay Sachs in the Cajun community.

_____

_____

_____

_____

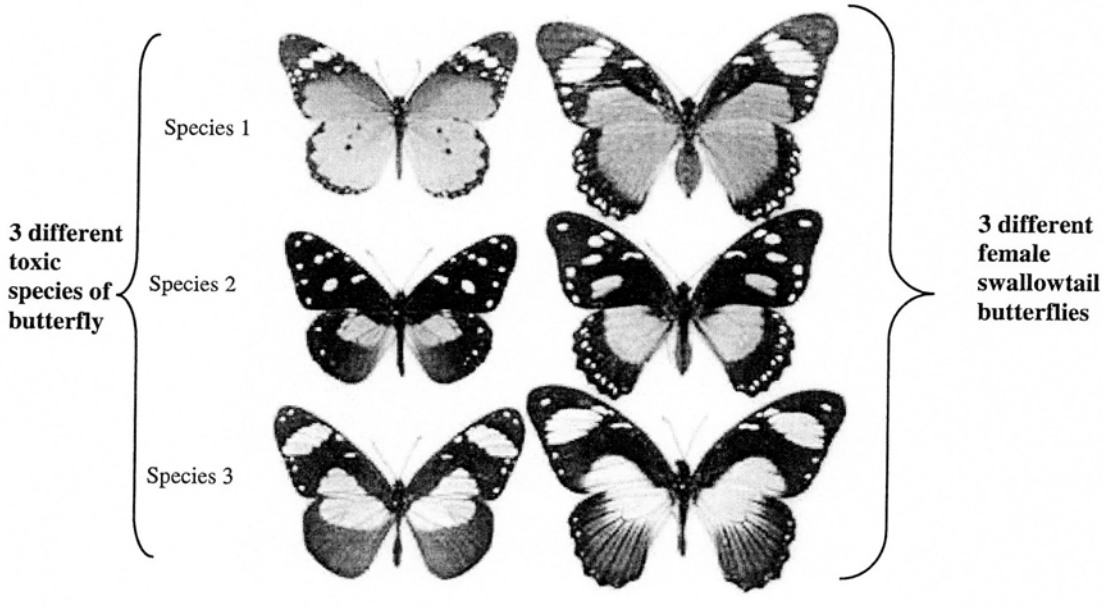
_____

(2 marks)

Total 5 marks

Question 4

African swallowtail butterflies (*Papilio dardanus*) are non-toxic butterflies that are preyed on by birds. The female swallowtails have evolved to resemble or mimic three unrelated species of butterflies that are toxic or distasteful to birds. The African swallowtailed mimics are only found in the same areas as the toxic butterflies that they are mimicking.



a What term is given to different colorations of the female swallowtail butterfly?

_____

(1 mark)

b How is this mimicry an advantage to the species?

(1 mark)

Male swallowtail butterflies do not show these different coloured forms and are all the same.

c Suggest an advantage to the species of having females show the mimic forms.

(1 mark)

d Name the mechanism that has brought about the development of this mimicry.

(1 mark)

e Outline the steps showing how this mimicry could have evolved.

(3 marks)

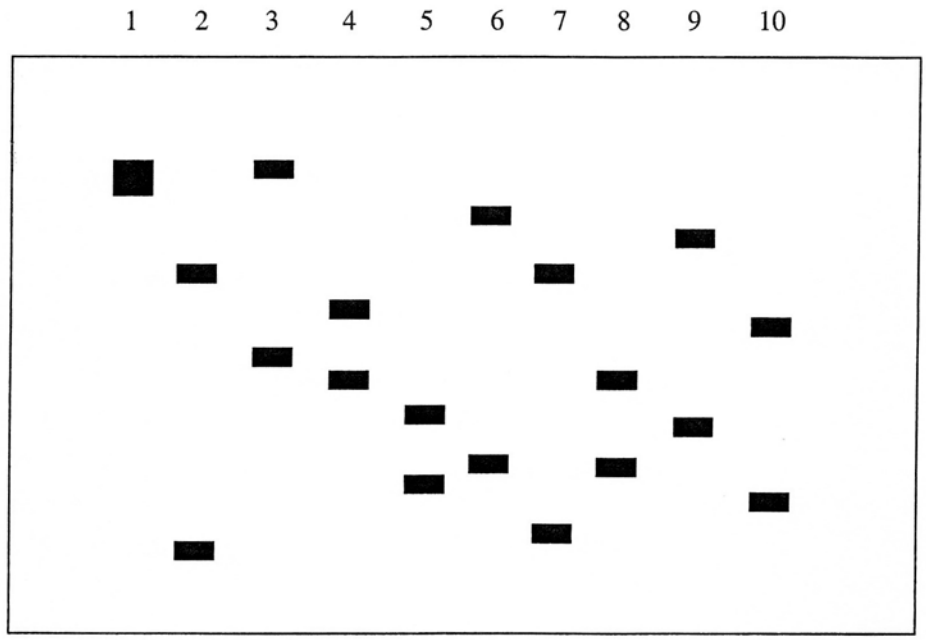
f If toxic species 2 were to disappear from an area, how might this affect the African swallowtail population in that area. Explain your answer.

(2 marks)

Total 9 marks

Question 5

Segments of DNA show variations in specific loci in human populations. The diagram below of gel electrophoresis, shows the variation in ten humans, (individuals 1 to 10), at one specific locus. Each band is an allele of the locus.



a Name the "genetic tool" used to cut the DNA.

_____

(1 mark)

b What is a special characteristic of this "tool"?

_____

(1 mark)

c Explain why the different individuals show a different pattern of DNA fragments after gel electrophoresis.

_____

_____

_____

(1 mark)

d Which individual(s) is/are homozygous for the allele?

_____

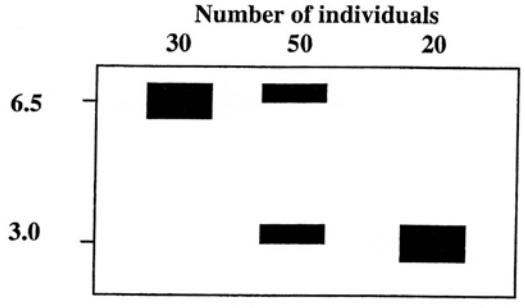
(1 mark)

e Do any individuals share an allele? If so name them.

_____

(1 mark)

If a large number of individuals are scored with respect to a particular locus, then the allelic frequencies can be determined for each band.
In a human population a particular allele can be cut to yield two fragments: a fragment which is 6.5 kb or a fragment that is 3.0 kb. The diagram below shows individuals with either a 6.5 kb fragment or a 3.0 kb or both. The number of individuals are shown above the bands.



f What is the total number of fragments in the population?

_____

(1 mark)

g Using your answer to **f** and **d** and the diagram above, calculate the frequency of the 6.5 fragment and hence the frequency of the allele that gave that fragment.

_____

(1 mark)

Total 7 marks

Question 6

The average human birth weight is around 3 kg. This ideal weight has been naturally selected for over 1 – 2 million years, up to the 20th century.

a Suggest two reasons why a weight of around 3 kg is considered to be an ideal weight.

_____

_____

_____

(2 marks)

By the late 1990s it was observed that this process of selection resulting in the average birth weight had virtually disappeared in wealthy developed countries, although it still operated in poor third world countries.

b Suggest why this pattern is observed.

_____

_____

_____

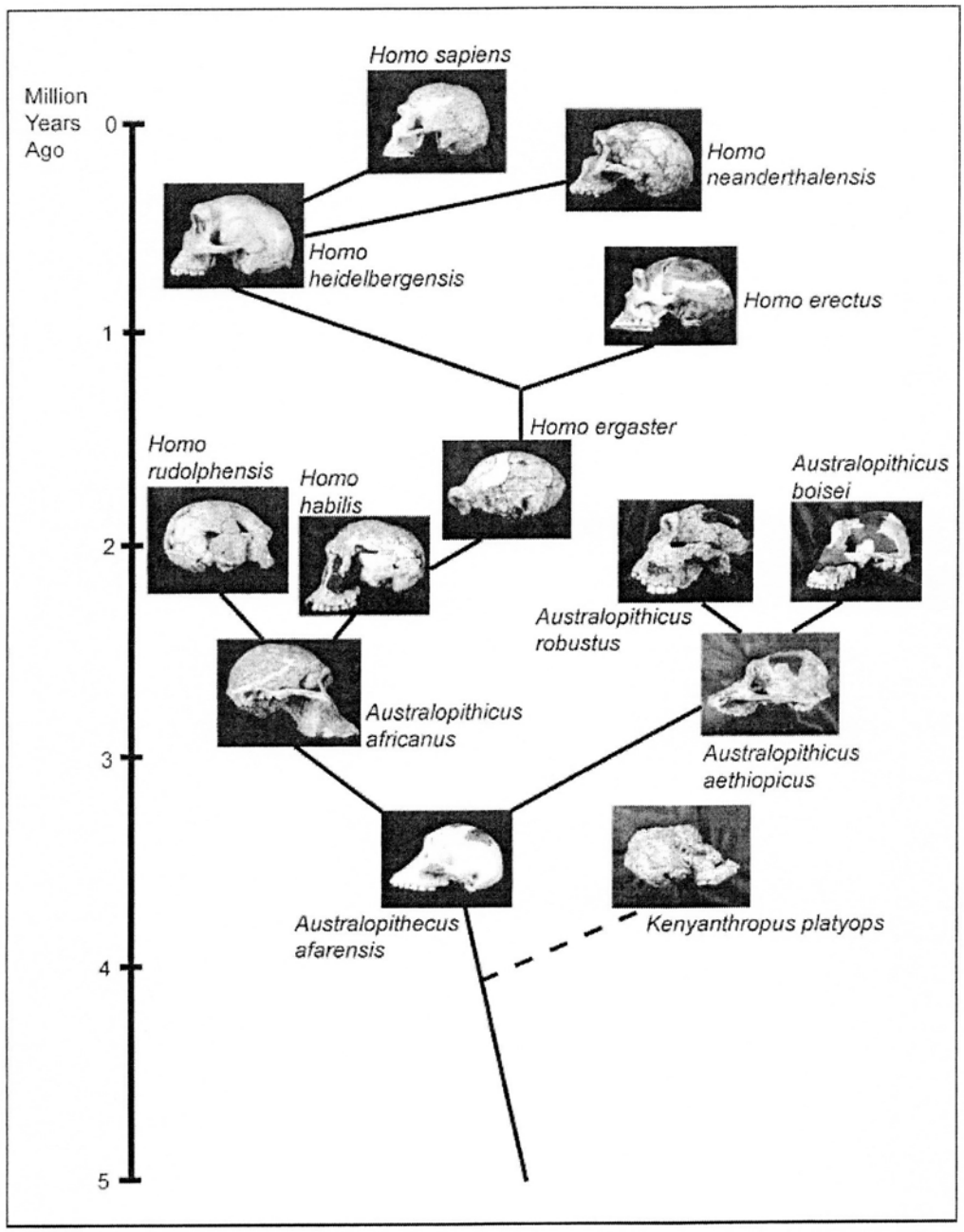
_____

(2 marks)

Total 4 marks

Question 7

The following diagram show a possible evolutionary pathway leading to modern humans based on fossil evidence.



a What method can be used to determine:

(i) the absolute age of fossils?

_____

(ii) the relative age of fossils?

_____

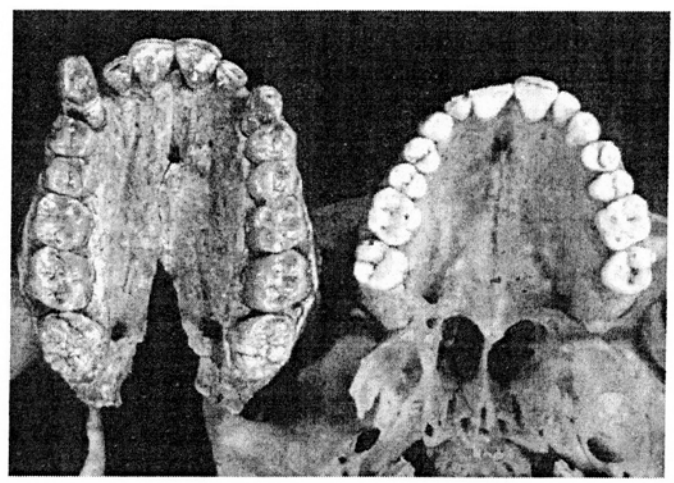
(1 + 1 = 2 marks)

b Give **two** structural features that would distinguish between *Homo erectus* and *Homo sapiens.*

_____

_____

(2 marks)



The photo above shows the dentition of modern man (right) and that of *Australopithicus afarensis* (left).

c What does the photo suggest about the diet of *Australopithicus afarensis* compared to modern man.
Give a reason for your answer.

_____

_____

_____

(2 marks)

Homo neanderthalensis lived in Europe alongside modern humans for thousands of years before they died out 30,000 years ago. There has been debate about whether they ever mated with *Homo sapiens.* Scientists have been sequencing the Neanderthal genome and have completed 60% of it.

d What is DNA sequencing?

_____

_____

(1 mark)

e How will the complete sequencing of *Homo neanderthalensis* genome help scientists to decide if Neanderthals interbred with *Homo sapiens*?

_____

_____

_____

(1 mark)

Determination of ancient hominid sequences of DNA is particularly difficult even when the hominid remains are well preserved.

f Outline **two** difficulties scientists would encounter when trying to accurately determine the hominid DNA sequence.

_____

_____

_____

(2 marks)

The conditions needed for fossilisation of any species are difficult to fulfil but the number of fossilised remains of the genus *Homo* is extremely low even when these conditions are considered.

g What conditions are needed for fossilization?

_____

_____

_____

(1 mark)

h Suggest why the number of fossilised remains of the genus *Homo* are so rare.

_____

_____

_____

_____

(1 mark)

Total 12 marks

END OF EXAMINATION

Acknowledgements

Websites:www.indmedica.com/journals.php?journalid=3...
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