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 questions to be answered	Number of marks	Suggested times (minutes)
A	25	25	25	30
B	4	4	50	60
		Total	**75**	**90**

- 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 19 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.

Published by STAV Publishing Pty Ltd. STAV House, 5 Munro Street, Coburg VIC 3058 Australia.
Phone: 61 + 3 9385 3999 • Fax: 61 + 3 9386 6722 • Email: stav@stav.vic.edu.au Website: http://www.stav.vic.edu.au

ABN 51 007 165 611

STAV Publishing
2003

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 placing a **CROSS** through the letter of your choice.

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	A	B	C	D
5.	A	B	C	D
6.	A	B	C	D
7.	A	B	C	D
8.	A	B	C	D
9.	A	B	C	D
10.	A	B	C	D
11.	A	B	C	D
12.	A	B	C	D
13.	A	B	C	D

14.	A	B	C	D
15.	A	B	C	D
16.	A	B	C	D
17.	A	B	C	D
18.	A	B	C	D
19.	A	B	C	D
20.	A	B	C	D
21.	A	B	C	D
22.	A	B	C	D
23.	A	B	C	D
24.	A	B	C	D
25.	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.

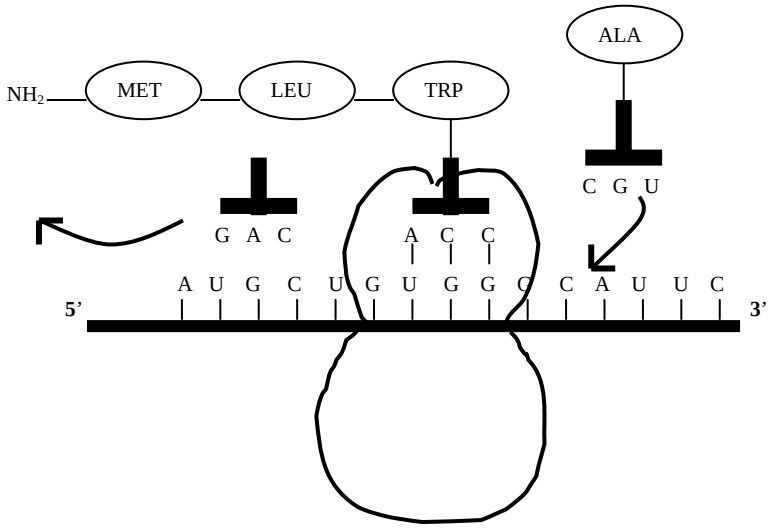
Each question has four possible correct answers. Only **one** answer for each question is correct. Select the answer that you believe is correct and indicate your choice on the Multiple Choice Answer Sheet by crossing the letter that corresponds with your choice of the correct answer.

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

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

Question 1

The following diagram represents a process that occurs in a cell in the pancreas.



This process is:

A. Aerobic respiration and formation of energy.
B. Translation and formation of protein.
C. Transcription and formation of mRNA.
D. Digestion by enzymes and formation of amino acids.

Question 2

The nucleotide sequences on DNA that have information encoding a polypeptide are:

A. Introns
B. Exons
C. Proteins
D. Promotors

Question 3

Scientists wishing to make multiple copies of a gene use the:

A. pepsin activation reaction.
B. gel electrophoresis.
C. polymerase chain reaction.
D. reverse transcriptase reaction.

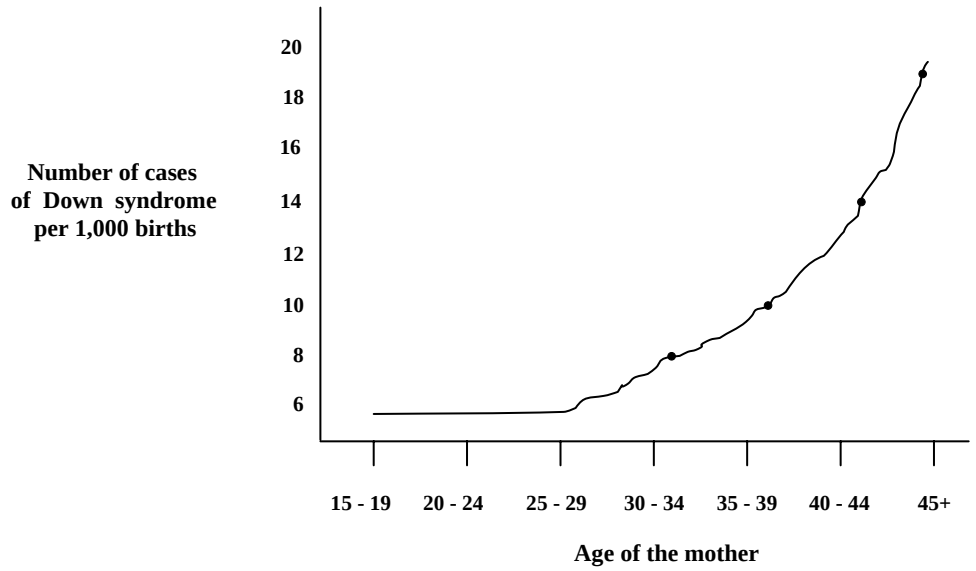
Question 4

The characteristic of a recessive, sex-linked trait in humans is that it:

A. never appears in females, only males.
B. is carried on the Y chromosome.
C. is carried on the X chromosome.
D. affects males and females equally.

Question 5

Down Syndrome is a genetic disorder in which the individual has 3 copies of chromosome 21. Below is a graph showing the incidence of Down syndrome and the age of the mother.



A correct inference that can be made from this graph is that with increasing maternal age there is a corresponding increase in:

A. Nondisjunction
B. Hybridisation
C. Polyploidy
D. Recombination

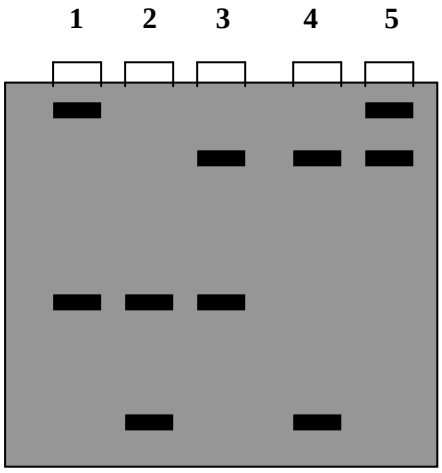
Question 6

A gene from a particular species of bacteria is 900 nucleotides long. The polypeptide chain that this gene could code for could contain approximately:

A. 900 amino acids.
B. 450 amino acids.
C. 2700 amino acids.
D. 300 amino acids.

Question 7

The following diagram represents a DNA fingerprint analysis using a single locus probe for a father and his four children. The lanes labeled 1 to 5 represent the 5 individuals.



The father would be:

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

Question 8

A person's skin cells are different from their muscle cells because:

A. they contain different genes.
B. they express different genes.
C. they have a different genetic code.
D. they have a different number of chromosomes.

Question 9

Point mutations:

A. occur at the 5' end of the DNA strand.
B. result from a break in the DNA strand at a particular point.
C. result when one nucleotide is changed for another.
D. force the genetic code to be read from the wrong point.

Question 10

A particular species of flowering plant can have blue flowers, white flowers or pale-blue flowers.
A cross between a blue-flowered plant and a white flowered plant produced all pale-blue flowered plants.
When these pale-blue plants were crossed, they produced the following plants.

Phenotype	Number of offspring
Blue	26
Pale-blue	52
White	22

From this data it can be concluded that:

A. The 2 alleles for colour show incomplete dominance.
B. Blue colour is dominant to white.
C. White is dominant to blue.
D. There are three different alleles controlling flower colour in these plants blue, pale blue and white.

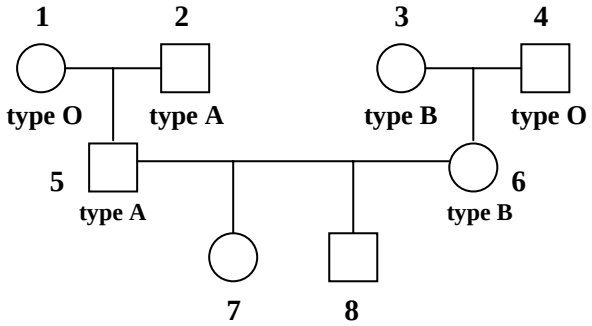
Question 11

Fruit flies (*Drosophila)* normally have red eyes but a whole range of mutations have resulted in a vast assortment of various eye colours. However no more than a single pair of alleles control eye colour in each fly. The inheritance of eye colour in fruit flies is an example of:

A. multiple alleles.
B. chromosomal alterations.
C. polyploidy.
D. crossing over.

Questions 12, 13 and 14 refer to the following information.

The following pedigree shows the inheritance of blood types.



Question 12

Individual **5** must have the genotype:

A. I^AI^A
B. I^Ai
C. ii
D. I^AI^B

Question 13

The individuals represented in the diagram that **must** be homozygous for blood type are:

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

Question 14

The blood types of the individuals **7** and **8** represented in the pedigree could be:

A. A or B only.
B. AB only.
C. A, B, or AB only.
D. A, B, AB, or O.

Question 15

The technology to replace genes in cells of humans is called:

A. Gene cloning.
B. Gene therapy.
C. Carrier screening.
D. DNA fingerprinting.

Question 16

A scientist sequencing one of the strands of a DNA molecule, found the sequence

5’ G A C T G T A C G T A 3’

The sequence of the complementary strand would be:

A. 5’ CTGACATGCAT 3’
B. 5’ GACTGTACGTA 3’
C. 5’ ATGCATGTCAG 3’
D. 5’ TACGTACAGTC 3’

Question 17

While looking for fossils on an eroded hillside, students discovered fossil coral and fish in one layer. In a layer just above, they found the fossil imprint of a fern frond and some fossil moss. Assuming the rock has not been disturbed, which of the following is the most probable conclusion?

A. The area had been underwater until recent times.
B. A forest that had once grown there but it had later been covered by sea water.
C. An ancient sea had been replaced by land a long time ago.
D. A freshwater lake had replaced an ancient saltwater sea a long time ago.

Question 18

When looking at fossils, the strongest fossil evidence for evolution is the fact that:

A. in undisturbed layers of rock strata, the older fossils are found in the deeper layers.
B. there are fossils of all life-forms to be found in the rock layers.
C. all fossils were formed at about the same time.
D. fossils have been shown to provide a complete record of the evolution of *Homo sapiens*.

Question 19

Hawaiian honeycreepers are small birds with similar body shape and size. However, they vary greatly in colour and beak shape. Each species occupies its own niche in the Hawaiian Islands and is adapted to the foods available in its niche. The evolution from a common ancestor to a variety of species is an example of:

A. divergent evolution.
B. parallel evolution.
C. hybridization.
D. convergent evolution.

Question 20

Australian farmers discovered that within a decade of the introduction of a new insecticide powder, nearly all of the target pests were immune to the usual-sized dose. The most likely explanation for this immunity to the insecticide is that:

A. all of the insects had become immune to the powder.
B. eating the powder had caused the insects to become less immune to it.
C. the powder destroyed a virus that causes disease in insects, thus allowing the insects to live longer.
D. the powder selected random mutations in a few insects and from these immune insects a resistant population of insects developed.

Question 21

Natural selection can best be defined as the:

A. survival of the biggest and strongest organisms in a population.
B. elimination of the smallest organisms by the biggest organisms in a population.
C. survival and reproduction of the organisms that are the fittest in a particular environment.
D. survival and reproduction of the organisms that are genetically best adapted to a particular environment.

Question 22

Upon close examination of the skeleton of an adult python, a pelvic girdle and leg bones can be observed. These features are an example of:

A. artificial selection.
B. homologous structures.
C. comparative anatomy.
D. vestigial structures.

Question 23

The theory of continental drift states that Africa and South America slowly drifted apart after once being a single landmass. The monkeys on the two continents, although similar, show numerous phenotypic differences.
These differences are explained by:

A. comparative anatomy of the two groups of monkeys.
B. comparative embryology of the two groups of monkeys.
C. the fossil record of the two groups of monkeys.
D. geographic isolation of the two groups of monkeys.

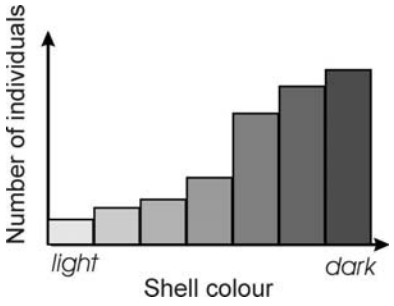
Question 24

Mutations such as polyploidy, inversions and deletions provide the genetic basis for:

A. evolution.
B. spontaneous generation.
C. biogenesis.
D. sexual reproduction.

Question 25

When checking shell colour for a species of snail found only in a remote area of Victoria seldom visited by humans, scientists discovered the distribution of individuals shown in the graph below.



Based on the information shown in the graph, the snail population is undergoing:

A. stabilising selection.
B. disruptive selection.
C. directional selection.
D. artificial selection.

END OF SECTION A

SECTION B - Short Answer Questions

Specific instructions for Section B

This section consists of 4 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

In a particular plant species leaf colour and leaf shape are controlled by two linked genes.

In the wild type plant the leaves are red. A recessive mutation in this gene causes white leaves. Wild-type leaves are pointed, and a recessive mutation in this gene causes them to be smooth.

a What is meant by linked genes?

_____

(1 mark)

The following crosses were performed.

Pure breeding plants with white, smooth leaves were crossed with pure breeding plants with red, pointed leaves. As expected all the plants had red pointed leaves.

b Why would this result be "expected"?

_____

_____

_____

_____

(2 marks)

Plants from the F1 cross above were then crossed with white, smoothed leaved plants and the results were tabulated below.

Phenotype	Number of offspring	Genotype
White smooth	40	
Red pointed	36	
White pointed	10	
Red smooth	14	

c Using the symbols:

R for red leaves
r for white leaves
P for pointed leaves
p for smooth leaves

complete the genotype column of the table on the previous page.

(2 marks)

d What phenotypes and what ratios would be expected if these genes were **not** linked?

Phenotypes_____

Ratios_____

(2 marks)

e What term is given to the offspring that are genotypically different from the parent genotypes?

_____

(1mark)

f Use the data above to calculate the distance that these genes are apart in map units.

_____

_____

(2 marks)

Total 10 marks

Question 2

Retts syndrome is a progressive neurodevelopmental disorder that almost exclusively affects females, with an incidence of 1 in 10,000 births. Individuals with Retts syndrome develop normally until the age of 6 to 18 months, and then they begin to lose the use of their hands and speech.
A gene that causes Retts syndrome, *MeCP2* has been found on the long arm of chromosome X.

a What term is given to genes found on the X chromosome?

_____

(1 mark)

Most abnormal genes that occur on the X chromosome cause disease in males more than in females.

b Why is it that in most cases diseases resulting from defective genes found on the X chromosome, affect more males than females?

_____

_____

_____

_____

(2 marks)

Retts is unusual in that it is a dominant condition found almost exclusively in females.
The gene *MeCP2* is believed to code for a protein that controls the expression of other genes in the cell. In Retts syndrome partial loss of this protein may lead to over expression of some genes resulting in the phenotype of the disease.

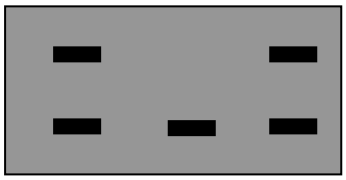
c Suggest a possible reason for the absence of this condition in males.

_____

_____

(1 mark)

In one case study a mother had two daughters to two different husbands. Both daughters had Retts syndrome. This tended to support the fact that it was the mother who had passed this condition on to her daughters. The mother showed no symptoms of the condition. The mother and daughters' DNA was examined by gel electrophoresis as shown below.



daughter 1 **mother** **daughter 2**

d How was this mother able to pass a dominant allele on to her daughters without showing any signs of the condition herself?

_____

_____

_____

(2 marks)

Current diagnostic testing of female babies suspected of suffering from Retts syndrome involves screening for sequence changes or mutations in the exons of the MECP2 gene. Firstly a blood sample is taken from the child and the DNA is extracted.The DNA is then subjected to PCR.

e What do the letters PCR stand for?

_____

(1 mark)

f What is the purpose of this reaction?

_____

_____

(1 mark)

The PCR products corresponding to exon 1, 2 and 3 are purified and using an automatic sequencer are sequenced and compared to the normal sequence for the MECP2 gene exons.

g What is meant by the exons of this gene?

_____

(1 mark)

At nucleotide position 316 in the DNA molecule of a Retts syndrome baby **C** has replaced **T.**

h What do the letters **T** and **C** stand for?

Letter **T** _____

Letter **C** _____

(2 marks)

i What is the name given to this type of mutation?

_____

(1 mark)

Below is a table showing the normal triplet in the DNA and the mutation.

Normal triplet		**Mutated triplet**	
Nucleotide number	**Nucleotide**	**Nucleotide number**	**Nucleotide**
316	**C**	**316**	**T**
317	**G**	**317**	**G**
318	**G**	**318**	**G**

The Genetic Code for 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**

Use the information from the tables above to answer the following questions.

j What is the change in the polypeptide formed in this mutation?

_____

(1 mark)

Another mutation at position 706 in the MECP2 gene a guanine has been deleted and not replaced by another nucleotide.

k Explain what effect this base deletion would have on the reading of the DNA molecule.

_____

_____

(2 marks)

Total 15 marks

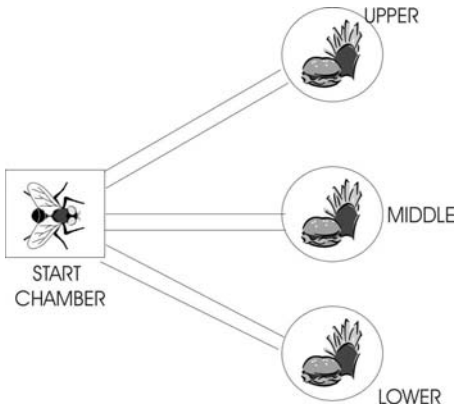
Question 3

Biologists have studied the feeding behaviour of rainforest flies both in the forest and in the laboratory. They have found that different flies preferred different foods. One type of preferred food is located high in the treetops; the other preferred food is located in the decaying leaf litter on the forest floor.

An experiment was designed to test a number of flies for geotaxis, a genetically determined behaviour. If a fly shows positive geotaxis, it flies downward. If a fly shows negative geotaxis it flies upward.

One hundred flies were captured, marked and placed in the maze shown in the diagram below. From the start chamber the fly could get food and leave the maze by flying to the upper chamber, the lower chamber, or straight ahead through the middle chamber. Each fly was placed in the maze 15 times and its path to food recorded.

Most flies consistently went upward and entered the upper chamber. Others consistently went downward and entered the lower chamber. A few flies chose the upward and downward chambers equal numbers of times; only one fly chose the middle chamber consistently.



a Name one factor in the flies' natural environment that might make a population of flies consistently fly upwards.

_____

(1 mark)

b Explain carefully how the factor that you named above could lead to the evolution of a population of flies that consistently flew to the upper chamber when tested in the laboratory.

_____

_____

_____

_____

(3 marks)

c Explain what might eventually happen if, in the wild, the flies developed into two populations with one showing positive geotaxis and the other showing negative geotaxis.

_____

_____

_____

(2 marks)

In an extension of the experiment, flies that chose the middle chamber were discarded. The other flies were placed into a large container and allowed to mate. The offspring of the flies were isolated and tested in the maze as their parents had been.

d This type of selection pressure when it occurs in the wild is called 'disruptive' or 'diversifying' selection. Explain how this type of selection could occur in the wild and why it would be termed 'diversifying' selection.

_____

_____

_____

_____

(2 marks)

In yet another variation of the experiment the upward-flying flies were collected and mated only with other upward-flying flies. When 200 of the offspring of these flies were tested, 198 flew upwards every time and 2 flew to the middle chamber most times. It was suggested that the flies that chose the middle chamber had new mutations in their geotaxis genes.

e Explain how a mutation could cause the two flies to behave as they did.

_____

_____

(2 marks)

Total 10 marks

Question 4

The family *Hominidae* (humans and their relatives) are thought to have separated approximately 5 million years ago from a common ancestor shared with the apes. These, in turn, evolved from an earlier arboreal primate, the *Aegyptopithecus* that lived in the forests now known as the Old World about 30 million years ago.

a What is meant by the term "common ancestor"?

_____

(1 mark)

A famous hominid fossil, known as "Lucy" is dated as being approximately 3.6 million years old and has been classified as a member of the species *Australopithecus afarensis*. Lucy is the oldest known hominid fossil with the skeletal structures necessary for bipedalism.

b How are modern apes different from Lucy in their mode of locomotion?

_____

(1 mark)

c What does being bipedal allow you to infer about Lucy's lifestyle?

_____

(1 mark)

Other fossil Australopithecines appear to have evolved in Africa, presumably from *A.afarensis*. *A.robustus* and *A.africanus* appear to have lived at the same time, but occupying different types of habitat. It does, however, appear likely that the two different types of australopithecines did occasionally meet.

d Explain whether or not *A.robustus* and *A.africanus* were likely to interbreed successfully when they met.

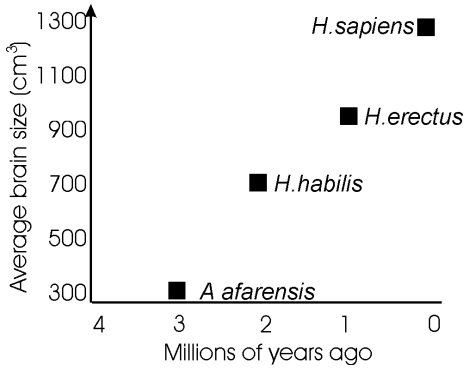
_____

_____

_____

(2 marks)

From the Australopithecines, it seems that early members of the genus *Homo* evolved some 2.5 million years ago. For about ½ a million years Australopithecines and early members of *Homo* both lived, probably still in Africa. But *Homo* slowly became larger and developed a much larger brain than the australopithecines. The Figure below illustrates this increase of brain size in the genus *Homo.*



e What is the likely survival advantage of a larger brain?

_____

_____

(1 mark)

Our closest relatives, *Homo habilis* and *Homo erectus* are now extinct, but they were responsible for the first wave of emigration of the hominids out of Africa, as their fossil remains have been found all over Africa as well as in many parts of the Old World (Europe and Asia).

f Why might the hominids have migrated out of Africa?

_____

_____

(1 mark)

Our own species, *Homo sapiens*, seems to have replaced *H.erectus* in Africa about ½ a million years ago, although *H. erectus* remained in Eurasia until about 250 000 years ago.

g Suggest why *H.erectus* survived longer out of Africa than within Africa.

_____

_____

(1 mark)

At the same time as the hominids were evolving from their common ancestor, the other primates were also evolving and migrating. Since the hominid ancestors are now extinct, scientists are interested in examining the similarities between the existing primates and ourselves to gain an insight into our own biochemical evolution.

To establish the extent of relatedness between species, several techniques have proved to be useful. One of these measures the difference between the DNA of various species. When the DNA of the orangutan, the gorilla, the chimpanzee and humans were compared it was found that less than 1% of the total DNA of these species differed. A rapidly evolving pseudogene region of the genome was analysed and that showed less than 3.5% variation as stated in the Table below.

Compared with DNA from:

DNA from: ↓	*Human*	*Chimpanzee*	*Gorilla*	*Orangutan*
Human	-	1.56	1.69	3.30
Chimpanzee	1.56	-	1.82	3.42
Gorilla	1.69	1.82	-	3.39
Orangutan	3.30	3.42	3.39	-

Percentage divergence or nucleotide sequences in a rapidly evolving pseudogene in four primate species.

h From the data on DNA comparison, which primate/s seem to be most closely related to humans? Explain your choice(s).

_____

_____

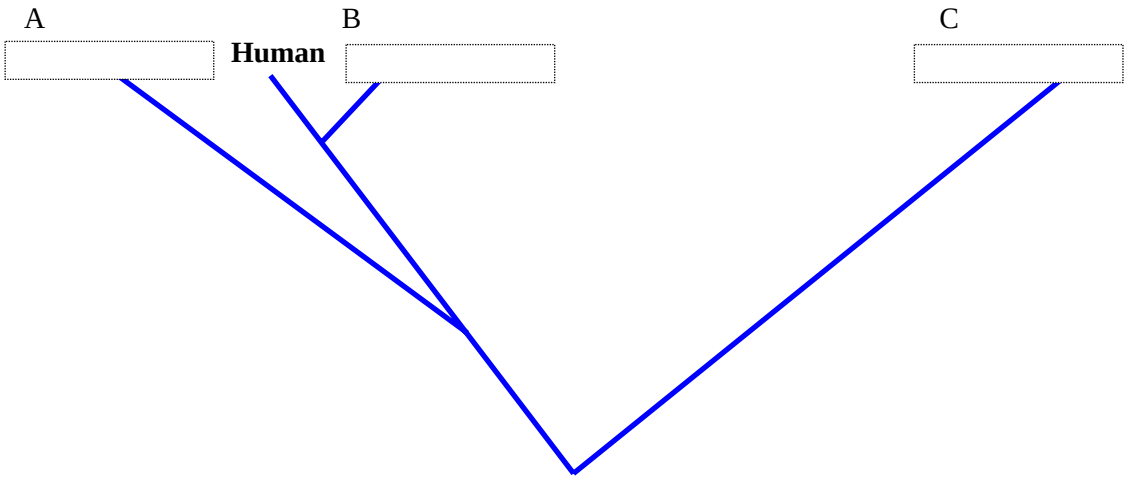
(2 marks)

i Of the non human primates, which seem to be most closely related from this data?

_____

(1 mark)

j Use the information in the previous Table to fill in the boxes A,B, and C below.



(1 mark)

Since the evolution of *Homo sapiens* began some 500 000 years ago, they have colonised many parts of the world. Now we can recognise the origins of many humans by their characteristic phenotypes. Skin and hair colour, eye shape and stature are just some of the phenotypic variations we can see in the "races" of our species.

k Is this an example of divergent, convergent or parallel evolution in the *H.sapiens* species?

_____

(1 mark)

l Predict whether or not you think humans may evolve into two or more species in the next 100 years. Justify your answer.

_____

_____

_____

(2 marks)

Total 15 marks

END OF EXAMINATION