

Student Name: \_\_\_\_\_

## BIOLOGY

### Unit 4 – Written examination 2



### 2009 Trial Examination

Reading Time: 15 minutes  
Writing Time: 1 hour and 30 minutes

### QUESTION AND ANSWER BOOK

#### Structure of book

| <i>Section</i> | <i>Number of questions</i> | <i>Number of questions to be answered</i> | <i>Number of marks</i> |
|----------------|----------------------------|-------------------------------------------|------------------------|
| A              | 25                         | 25                                        | 25                     |
| B              | 7                          | 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 permitted in this examination.

#### Materials supplied

- Question and answer book of 23 pages.

#### Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

**Students are NOT permitted to bring mobile phones and/or any other electronic devices into the examination room.**

**SECTION A- Multiple-choice questions**

**Instructions for Section A**

Answer **all** questions.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks are **not** deducted for incorrect answers.

If more than 1 answer is completed for any question, no mark will be given.

**Question 1**

Chromosomes consist of coiled up chromatin. The substances that are incorporated into chromatin are:

- A. Chromatids only
- B. Histones and DNA
- C. Amino acids only
- D. Nucleotides only

**Question 2**

Which of the following events occurs first during DNA replication?

- A. Okazaki fragments are spliced together by DNA ligase
- B. Hydrogen bonds reform between the newly synthesised strands
- C. DNA polymerase produces daughter strands of DNA
- D. Helicase breaks the hydrogen bonds in the parental strand

**Question 3**

Which of the following is the initial product of transcription?

- A. Messenger RNA
- B. Pre mRNA
- C. Transfer RNA
- D. Ribosomal RNA

**Question 4**

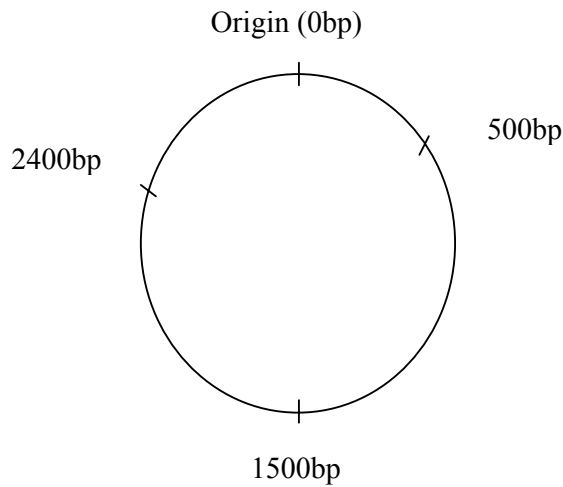
Which of the following statements about a double strand of DNA is most correct?

- A. There are twice the number of sugar groups as there are phosphate groups
- B. The number of guanine bases equals the number of thymine bases
- C. The number of phosphate groups equals the number of nitrogenous bases
- D. The number of uracil bases equals the number of adenine bases

**SECTION A - continued**

**Question 5**

The diagram below is the map of a plasmid 3000 base pairs (bp) in size with the cut sites for the restriction enzyme Hind III shown.



What size would the fragments be if the plasmid were digested with Hind III?

- A. 3 fragments: 500bp, 1500bp and 2500bp in size
- B. 3 fragments: 500bp, 900bp and 1000bp in size
- C. 3 fragments: 500bp, 1000bp and 1500bp in size
- D. 3 fragments: 900bp, 1000bp and 1100bp in size

**Question 6**

Some viruses such as the HIV virus have an enzyme called reverse transcriptase. The function of this enzyme is to:

- A. Use a DNA template to produce mRNA
- B. Use an mRNA template to produce tRNA
- C. Use an mRNA template to produce DNA
- D. Use an amino acid sequence to produce mRNA

**Question 7**

If a scientist wishes to clone a specific gene they must first locate the specific fragment of DNA required. The tool used to locate a fragment of DNA is:

- A. A gene probe
- B. Electrophoresis
- C. Karyotyping
- D. DNA sequencing

**SECTION A – continued**  
**TURN OVER**

**Question 8**

The diagram below shows a replicated chromosome taken from a cell during metaphase of meiosis 1. It consists of 2 chromatids joined by a centromere.



The number of molecules of DNA present in the molecule is:

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

**Question 9**

Meiosis and mitosis are both forms of cellular division, with both processes producing daughter cells. Which of the following statements involving one or both of these processes is *incorrect*?

- A. Bivalent chromosomes are only seen during meiosis
- B. The centromere splits during the first meiotic division.
- C. The output of meiosis is a gamete.
- D. Cytokinesis occurs at the conclusion of each process.

**Question 10**

A litter of kittens that resulted from the mating of 2 short tailed cats contains 2 kittens with long tails, 4 kittens with short tails and 2 kittens with no tails. The mode of inheritance in this example is:

- A. Incomplete dominance
- B. Codominance
- C. Autosomal inheritance
- D. X linked inheritance

**Question 11**

Which of the following genotypes are the most appropriate for the parents of the kittens in Question 10?

- A.  $Tt \times Tt$
- B.  $T^L T^L \times T^S T^S$
- C.  $T^L T^N \times T^L T^N$
- D.  $X^L X^N \times X^N Y$

**SECTION A - continued**

*Use the following information to answer questions 12 and 13*

Coat colour and texture in guinea pigs is governed by 2 genes each of which have 2 alleles.

Coat colour gene

B = black fur

b = white fur

Coat texture gene

C = course fur

c = smooth fur

### Question 12

A breeder carried out a test cross between 2 guinea pigs. The expected phenotypic ratio in the offspring would be:

- A. 1:1:1:1
- B. 9:3:3:1
- C. 3:1
- D. 1:2:1

### Question 13

Further test crosses were performed and the phenotypes of the offspring recorded. The table below shows the number of offspring with each of the four possible phenotypes

| Phenotype             | Number of Organisms |
|-----------------------|---------------------|
| Black with course fur | 98                  |
| Black with smooth fur | 32                  |
| White with course fur | 28                  |
| White with smooth fur | 87                  |

The most accurate conclusion that can be drawn from this information is:

- A. The genes for fur colour and texture are codominant
- B. The genes for fur colour and texture are independently assorted
- C. The genes for fur colour and texture come from different parents
- D. The genes for fur colour and texture are linked

### Question 14

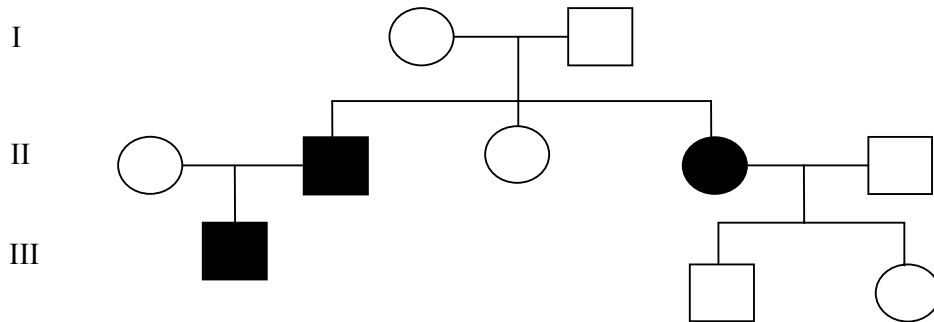
Human height is governed by the expression of a series of genes at multiple loci. This can be interpreted to mean:

- A. The genes causing this trait are linked
- B. This is an example of polygenic inheritance
- C. Some of the genes act as repressors
- D. Discontinuous phenotypic variation would be expected

**SECTION A – continued**  
**TURN OVER**

*Use the pedigree chart below to answer questions 15 and 16*

This pedigree chart shows the inheritance of a genetic condition over 3 generations.



**Question 15**

The most likely form of inheritance of this trait is:

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

**Question 16**

Which of the following conclusions is the most accurate?

- A. Individual II-1 is heterozygous
- B. Individual I-1 is homozygous
- C. Individual III-1 is heterozygous
- D. Individual II -3 is homozygous

*Use the following information to answer Questions 17 and 18*

Before 1492 it is estimated that the population of American Bison was approximately 60 million. By 1890 the population had fallen to approximately 750. The population has been slowly recovering over many years and today there are approximately half a million American Bison.

**Question 17**

The situation described above is an example of:

- A. The founder effect
- B. A population bottleneck
- C. Genetic drift
- D. Artificial selection

**SECTION A – continued**

**Question 18**

If a scientist obtained DNA samples from a number of American Bison populations it is most likely that they would find:

- A. Most of their genetic diversity has been lost
- B. There is a large range of phenotypic variation
- C. All of the current American Bison are descended from a single bull
- D. All of the populations of American Bison would be very unhealthy.

**Question 19**

A species of garden snails have shells that range in colour from cream through light brown to dark brown. After several years it is noticed that the population of snails now only has dark brown shells. This is an example of:

- A. Diversifying selection
- B. Directional selection
- C. Disruptive selection
- D. Stabilising selection

**Question 20**

The structure of the mammalian eye such as that of humans has been found to be very similar in structure and function to the eye of some cephalopod molluscs such as the giant squid. Identify which of the following statements is most correct.

- A. The structures are homologous and the two species share a recent common ancestor
- B. The structures are homologous and the two species do not share a recent common ancestor
- C. The structures are analogous and the two species share a recent common ancestor
- D. The structures are analogous and the two species do not share a recent common ancestor

**Question 21**

Organisms from two different species were found to have nucleotide sequences that were virtually identical, which when translated produced proteins that performed the same function. The most likely reason for this is that these two species:

- A. Have identical DNA
- B. Are evolving into the same species
- C. Have a similar evolutionary background
- D. Have been exposed to similar environmental conditions

**SECTION A – continued**  
**TURN OVER**

**Question 22**

Eukaryotic cells have a single circle of mitochondrial DNA consisting of approximately 16.5 kilobases. Mitochondrial DNA is useful in establishing evolutionary relationships between species because:

- A. Recombination occurs at a regular rate
- B. It is present in smaller amounts than nuclear DNA
- C. Substitution mutations occur at a greater rate than nuclear DNA
- D. It is only present in female gametes

**Question 23**

Bill colour of male zebra finches varies in colour ranging from light red to bright red. Females tend to mate with males that have brighter red bills. This choice is an example of:

- A. Colour differentiation
- B. A selection pressure
- C. Adaptive radiation
- D. Genetic drift

**Question 24**

The diagram below represents some undisturbed layers of sedimentary rock

|         |
|---------|
| Layer 1 |
| Layer 2 |
| Layer 3 |
| Layer 4 |
| Layer 5 |

What assumptions can be made from this data?

- A. The fossils in layer 2 were formed after the fossils in layer 3
- B. The fossils in layer 3 are more complex than those in layer 4
- C. The fossils in layer 5 are ancestors of the fossils in layer 4
- D. The fossils in layer 5 are the most recent

**SECTION A – continued**



**Question 25**

A scientist locates the skeletons of 2 different hominids and makes the following comparisons between the 2 skeletons.

| FEATURE              | SKELETON 1                    | SKELETON 2                     |
|----------------------|-------------------------------|--------------------------------|
| Thigh bone           | Angles outwards from the knee | Is at right angles to the knee |
| Spine shape          | Curved spine                  | Straight spine                 |
| Supraorbital ridges  | Absent                        | Large                          |
| Femur                | Long compared to arm length   | Short compared to arm length   |
| Skeleton description | Gracile                       | Robust                         |

Based upon this information where would you expect to find the foramen magnum located in skeleton 1?

- A. At the lower end of the femur
- B. Towards the rear of the base of the skull
- C. In the centre of the base of the skull
- D. Aligned with the top of the femur

**END OF SECTION A  
TURN OVER**

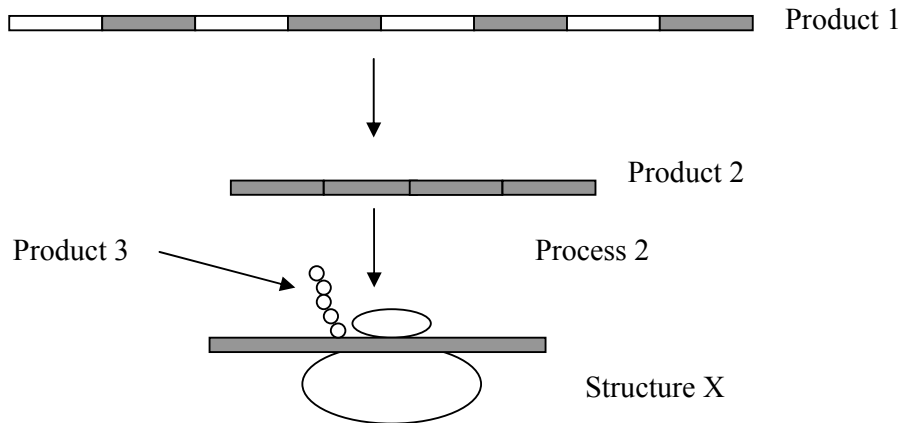
**SECTION B- Short-answer questions**

**Instructions for Section B**

Answer all questions in the spaces provided.

**Question 1**

The diagram below shows some of the stages that occur during protein synthesis.



- a. Identify products 1 and 2. Explain why product 1 is longer than product 2.

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2 marks

- b. Identify the enzyme responsible for annealing product 2.

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1 mark

**SECTION B - Question 1- continued**

- c. Briefly explain why organisms regulate production of proteins.

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1 mark

Use the genetic code table below to assist you to answer the following questions

| Codon | Amino Acid | Codon | Amino Acid | Codon | Amino Acid | Codon | Amino Acid |
|-------|------------|-------|------------|-------|------------|-------|------------|
| UUU   | Phe        | UCU   | Ser        | UAU   | Tyr        | UGU   | Cys        |
| UUC   | Phe        | UCC   | Ser        | UAC   | Tyr        | UGC   | Cys        |
| UUA   | Leu        | UCA   | Ser        | UAA   | Stop       | UGA   | Stop       |
| UUG   | Leu        | UCG   | Ser        | UAG   | Stop       | UGG   | Trp        |
| CUU   | Leu        | CCU   | Pro        | CAU   | His        | CGU   | Arg        |
| CUC   | Leu        | CCC   | Pro        | CAC   | His        | CGC   | Arg        |
| CUA   | Leu        | CCA   | Pro        | CAA   | Gln        | CGA   | Arg        |
| CUG   | Leu        | CCG   | Pro        | CAG   | Gln        | CGG   | Arg        |
| AUU   | Ile        | AUC   | Thr        | AAU   | Asn        | AGU   | Ser        |
| AUC   | Ile        | ACC   | Thr        | AAC   | Asn        | AGC   | Ser        |
| AUA   | Ile        | ACA   | Thr        | AAA   | Lys        | AGA   | Arg        |
| AUG   | Met        | ACG   | Thr        | AAG   | Lys        | AGG   | Arg        |
| GUU   | Val        | GCU   | Ala        | GAU   | Asp        | GGU   | Gly        |
| GUC   | Val        | GCC   | Ala        | GAC   | Asp        | GGC   | Gly        |
| GUA   | Val        | GCA   | Ala        | GAA   | Glu        | GGA   | Gly        |
| GUG   | Val        | GCG   | ala        | GAG   | Glu        | GGG   | Gly        |

- d. The following DNA sequence represents the start of a leading strand that codes for the production of a hormone.

TACTTGCCAGCTGACAGT

Write the mRNA sequence for this DNA sequence.

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1 mark

**SECTION B - Question 1- continued**  
**TURN OVER**

- e. An A is substituted for the 10<sup>th</sup> base in the DNA sequence. Identify the type of mutation in this case and explain the effect that the mutation will have on the amino acid sequence.

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3 marks

- f. Gene splicing is a process in which two or more fragments of DNA are recombined. An example of this technique is the splicing of the human insulin gene into a bacterial plasmid which, when inserted into a bacterium enables it to produce the human insulin protein. Briefly explain what property of the genetic code is being utilised in this technique.

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1 mark

- g. Gene therapy is another technique where DNA is manipulated. Other than causing changes to the DNA sequence, identify one similarity and one difference between gene splicing and gene therapy.

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2 marks

Total 11 marks

**SECTION B - continued**

**Question 2**

Turner syndrome, also known as Ulrich-Turner syndrome is a chromosomal disorder that only affects females. One cause of this syndrome is monosomy X; affected individuals only have 1 copy of the X chromosome instead of 2. Symptoms of this condition include short stature, broad chest and lymphodema. Affected individuals may also experience health problems such as congenital heart disease, diabetes and infertility.

- a. Explain the sequence of events that occurs during meiosis which causes these females to develop Turner syndrome.

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2 marks

- b. What term is used to describe any condition where the number of chromosomes in a somatic cell is not an exact multiple of the haploid number?

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1 mark

Total 3 marks

**Question 3**

Coat colour in horses is controlled by a single gene with 2 alleles. Several crosses were performed between pure breeding chestnut (reddish brown coloured) horses and pure breeding cremello (cream coloured) horses. All of the F1 offspring are palomino (light brown coloured).

- a. Use the information supplied above to write appropriate symbols for the 2 alleles.

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1 mark

- b. Identify the type of inheritance in this case.

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1 mark

**SECTION B - Question 3 – continued**  
**TURN OVER**

- c. Use the space below to establish the genotypic and phenotypic ratio of the **F2** generation.

3 marks

- d. A farmer has a chestnut mare which gives birth to twin foals, one is palomino and the other is chestnut. He wishes to identify the stallion. Use your knowledge of genetics to establish the coat colour of the stallion and draw a punnett square to support your answer.

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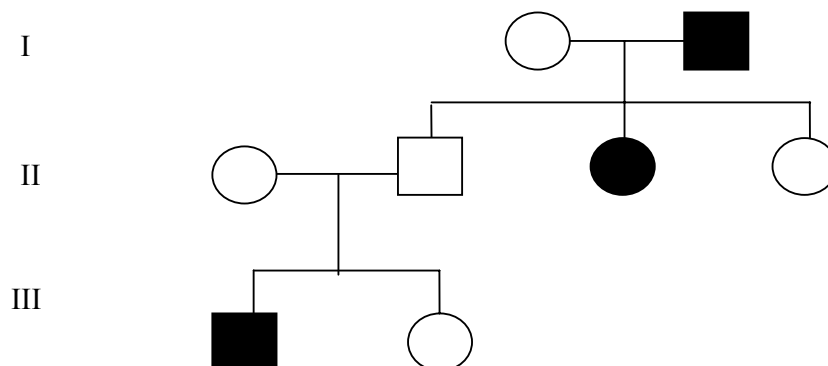
2 marks

Total 7 marks

**SECTION B - continued**

**Question 4**

Colour blindness is an X linked recessive disorder. The pedigree chart below shows the inheritance of colour blindness over several generations.



- a. Use the information supplied above to explain why the mode of inheritance for this condition cannot be X linked dominant.

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2 marks

- b. Individual II-4 marries an unaffected male, but is concerned that she may have a child with the condition. Use the information provided to establish whether she should be worried or not.

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2 marks

Total 4 marks

**SECTION B - continued**  
**TURN OVER**

**Question 5**

Electrophoresis is a separation technique that allows molecules such as DNA or proteins to be separated. Gels made of agarose or polyacrylamide are covered with a salty buffer solution. Samples of DNA are placed into wells at the negative end of the gel.

- a. Briefly explain why it is essential that the DNA samples are placed into the wells at the negative end of the gel.

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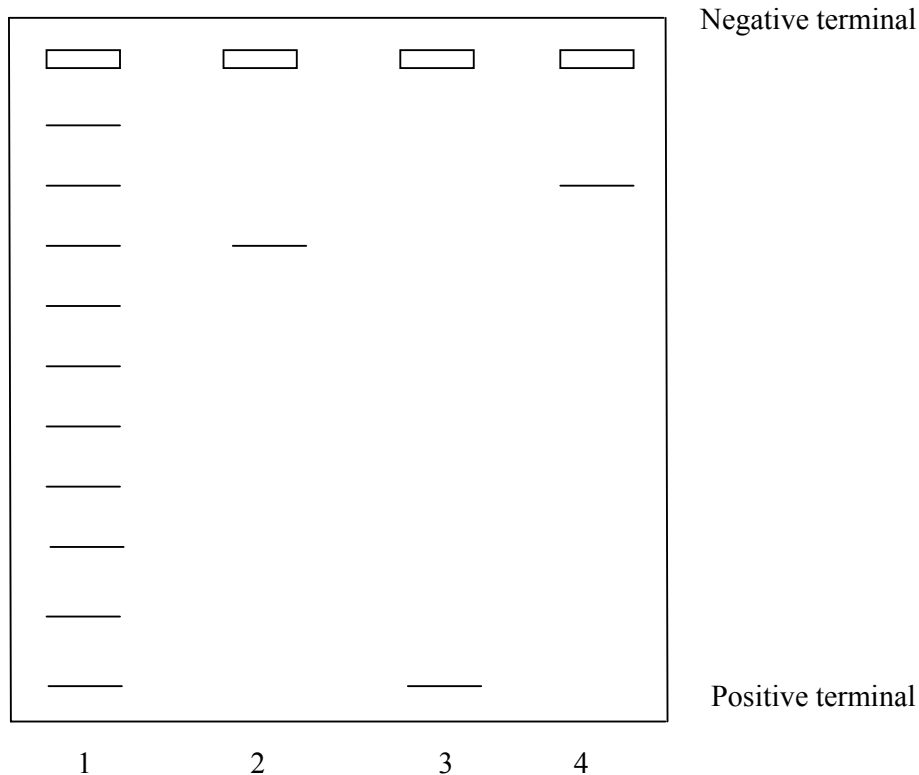
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1 mark

When performing electrophoresis a DNA ladder or marker solution should always be used. These solutions contain DNA fragments of a known size. The manufacturers of such a solution have provided the following information about their product. “The internal lane marker solution is a stock solution consisting of 10 DNA fragments ranging in size from 1kb to 10kb. The fragments are spaced every 1kb.”

The diagram below represents an electrophoresis gel. Lane 1 contains the marker solution and the other 3 lanes contain samples to be identified.

- b. The diagram below represents an electrophoresis gel. Correctly label the size of all of the fragments in lane 1.



1 mark

**SECTION B - Question 5 - continued**



- c. A plasmid is 8kb in length and the gene to be inserted is 1kb in length. Identify which of the lanes contains the DNA fragment consisting of the plasmid annealed to the gene to be inserted. Use the data supplied to support your answer.

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2 marks

- d. The end result of annealing a plasmid with the desired gene is called a recombinant plasmid, and the bacteria which take up recombinant plasmids are referred to as transformed. Not all of the bacteria that are exposed to the plasmid take it up. Design an experiment that would enable a scientist to differentiate the transformed bacteria and explain how the transformed bacteria could be identified.

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2 marks

- e. From your studies this year identify another application of electrophoresis.

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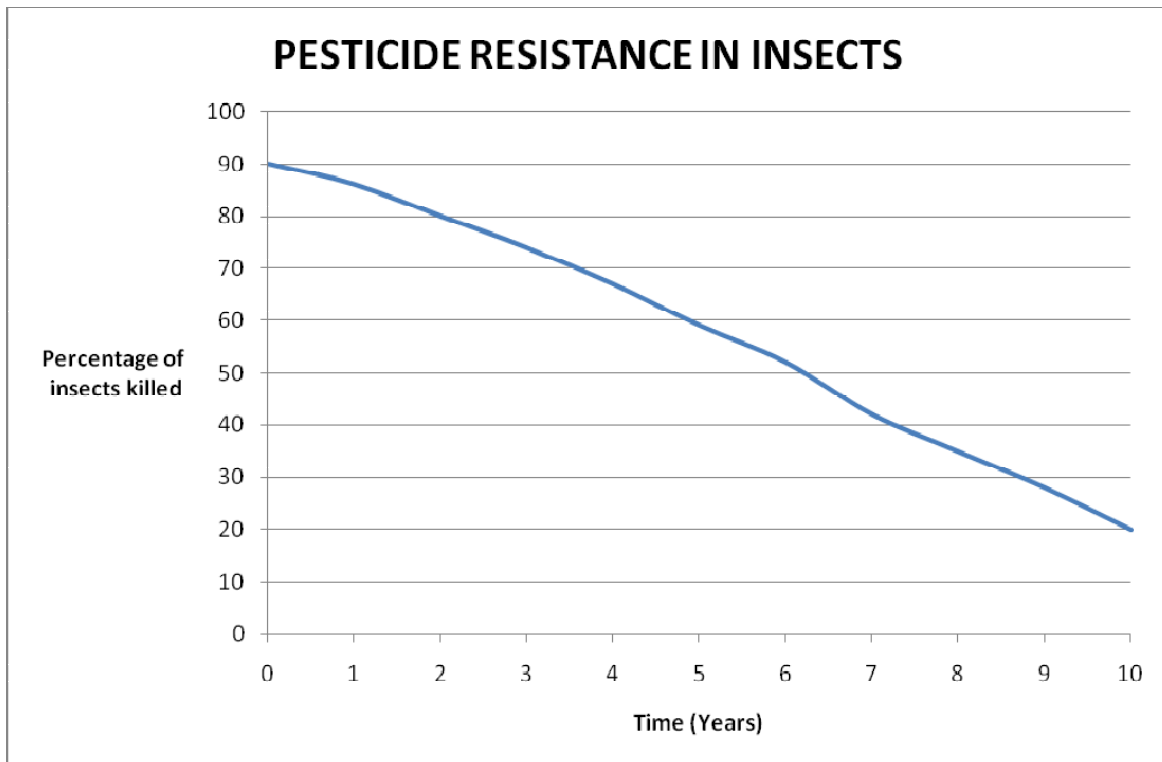
1 mark

Total 7 marks

**SECTION B – continued**  
**TURN OVER**

**Question 6**

A farmer was losing large quantities of his crop to insect infestations and began to fumigate his fields with pesticides. The chart below shows the effect of using pesticides over a period of 10 years.



- a. Use the data in the graph to explain the process which caused the percentage of insects killed by the pesticide to alter.

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3 marks

**SECTION B – Question 6 - continued**

- b.** It is axiomatic that natural selection does not operate unless there is phenotypic variation. Explain why natural selection does not operate in populations where the organisms are genetically identical.

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1 mark

- c.** Identify 2 sources of variation in a population of organisms that reproduce sexually.

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1 mark

- d.** Explain the difference between natural selection and artificial selection.

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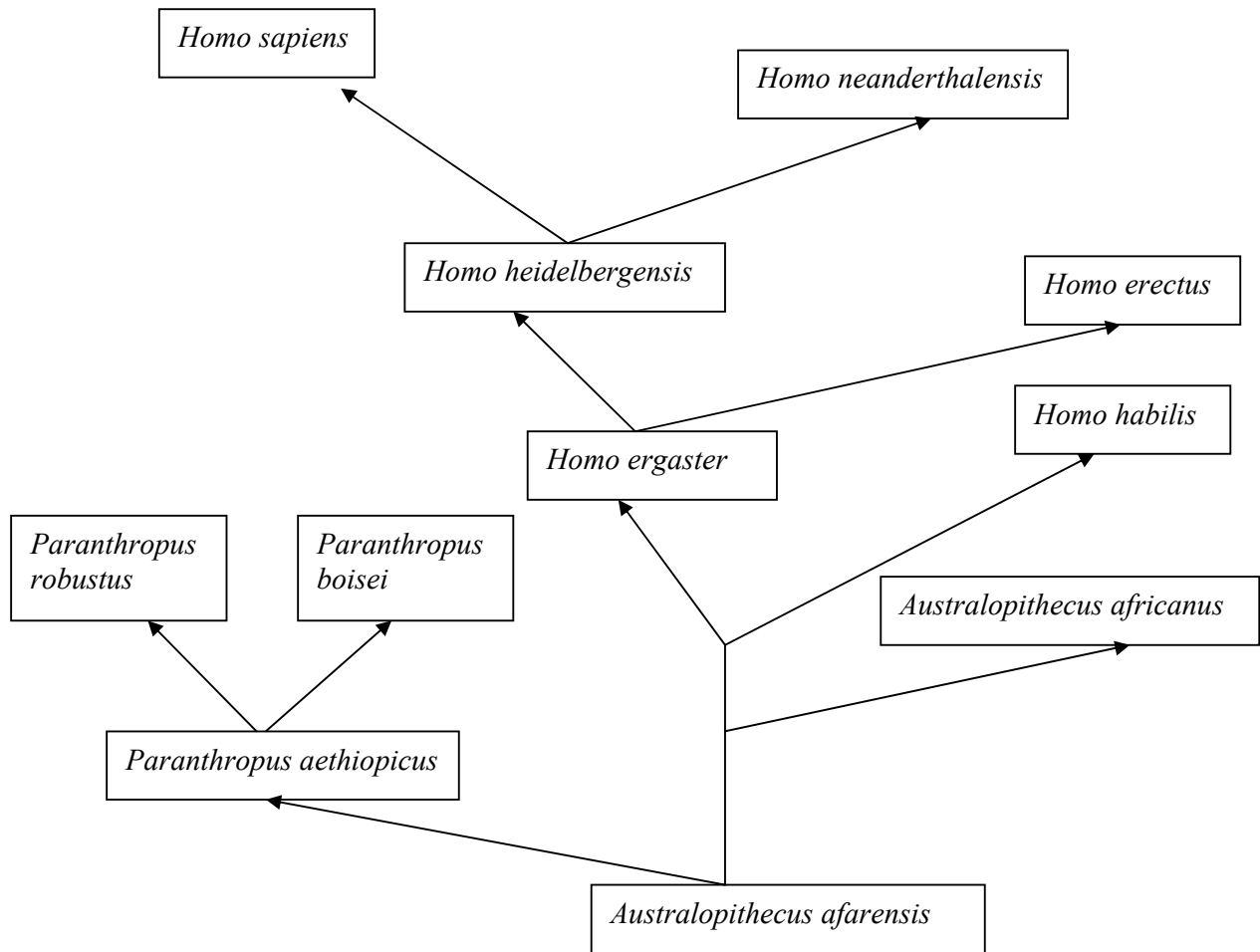
1 mark

Total 6 marks

**SECTION B – continued**  
**TURN OVER**

**Question 7**

The diagram below shows a possible simplified view of the evolutionary relationships between hominins covering the time period from approximately 4 million years ago to the current day.



- a. The origin of modern humans is a subject of debate. Although there have been many theories over time, there are currently 2 main hypotheses. Identify 1 of these hypotheses and provide a brief summary of the hypothesis selected.

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2 marks

**SECTION B - continued**

- b. Hominid fossils from areas all over the world have been used to attempt to piece together a linear relationship between different species of hominids. However, there are many gaps or “missing links” in the fossil record. When new discoveries are made these are either incorporated into the existing view or used to change it. A few examples of additional hominid species discovered in the last decade include: *Homo floresiensis*, *Homo antecessor*, *Australopithecus anamensis* and *Kenyanthropus platyops*.

Some of these species are considered to be intermediate or transitional forms. Explain the importance of transitional forms in developing our understanding of how a species, such as *Homo sapiens* has evolved.

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2 marks

- c. A cave which had been blocked up was excavated and there was found to be several occupation horizons (layers indicating occupation by different groups of people). Deposits of ash and charcoal were found along with fossilised bones, broken pottery vessels, flint tools and animal bones. Several individuals were also found to be buried along with flint knives, leaf shaped arrowheads and stone axes. A few personal items such as bone pins and shell necklaces were found mixed with the material used to fill in the burial sites.

What type of evolution is this an example of?

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1 mark

- d. All the fossilised bones found in the cave were extremely well preserved. Provide one reason why well preserved specimens are frequently found in caves.

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1 mark

**SECTION B- Question 7 – continued**  
**TURN OVER**

- e. It is believed that these remains are between 28,000 and 50,000 years old. Identify an absolute dating technique that could be used to verify this assertion.

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1 mark

- f. Remains of Neanderthals and their tools have been found at Saint Cezaire in France. The age of these finds has been dated at between 31,000 and 34,000 years. This overlaps with the earliest remains of modern humans found in the same area. In another project fossils of modern humans have been found at Jebel Qafzeh in Israel, which are 100,000 years old, while Neanderthal remains from the nearby Kebara caves are 60,000 years old.

What assumptions could be made by comparing the ages of the fossils?

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1 mark

- g. Would members of these 2 species have homologous features or analogous features? Use the diagrammatic information supplied to justify your answer.

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2 marks

**SECTION B- Question 7 – continued**

- h. Haemoglobin is a small protein with a primary structure of 146 amino acids. The molecule has been studied for the glimpse it gives into evolutionary biology. Both humans and chimpanzees have identical molecules, while there is a greater difference between human haemoglobin and that of other primates as shown below.

Use the information provided below to construct a cladogram (phylogenetic tree) showing the possible evolutionary relationship between these organisms in the space provided.

| Primate         | Number of differences from humans |
|-----------------|-----------------------------------|
| Chimpanzee      | 0                                 |
| Gorilla         | 1                                 |
| Gibbon          | 3                                 |
| Rhesus Monkey   | 8                                 |
| Squirrel Monkey | 9                                 |

1 mark

Identify one conclusion that could be obtained by analysing this information.

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1 mark

Total 12 marks

**END OF QUESTION AND ANSWER BOOK**