

THIS BOX IS FOR ILLUSTRATIVE PURPOSES ONLY

2010 Trial Examination

STUDENT NUMBER

Figures

Words

Letter

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BIOLOGY

Unit 4 – Written examination 2

Reading time: 15 minutes

Writing time: 1 hour and 30 minutes

QUESTION & 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 26 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 unauthorised electronic communication devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

Select the response that is **most 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.

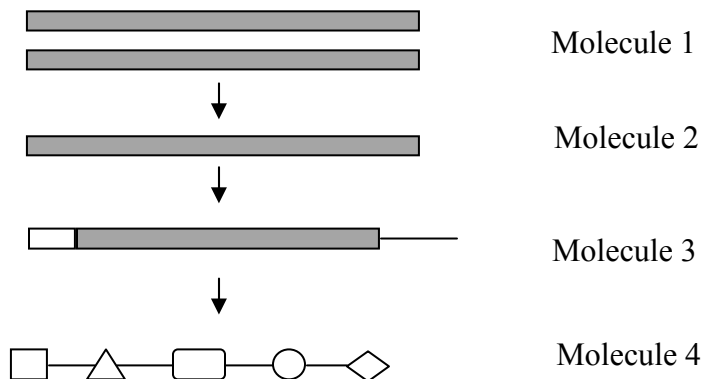
Question 1

Which of the following statements about DNA is true?

- A. The number of sugar molecules and nitrogenous bases are equal
- B. There are twice as many phosphate groups as sugar molecules
- C. There are the same number of adenine and guanine bases
- D. There are twice as many nitrogenous bases as there are phosphate groups

Use the following information to answer questions 2 and 3

Several molecules are shown below:



Question 2

The most correct name for molecule 2 is:

- A. DNA
- B. Exon
- C. Messenger RNA
- D. Primary transcript

SECTION A - continued

Question 3

The purpose of the structures on the ends of molecule three is that they:

- A. Contain coding for amino acids
- B. Cause correct orientation of the molecule
- C. Allow commencement of protein synthesis
- D. Are involved in gene regulation

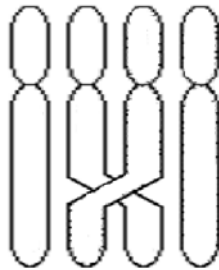
Question 4

A cellular process involves the pairing of homologous chromosomes followed by disjunction of these pairs. Which of the following terms identifies this process?

- A. Meiosis
- B. Mitosis
- C. Segregation
- D. Translation

Question 5

The diagram below shows a cellular process



Which of the following best describes the process shown?

- A. Mutations cause random breakage and recombination of chromosomes
- B. Inbreeding causes gene linkage between homologous chromosomes
- C. Crossing over occurs during synapsis causing increased variation
- D. Non disjunction causes an exchange of materials during synapsis

SECTION A - continued
TURN OVER

Question 6

In mice the trait for grey fur is dominant over the trait for black fur. In a litter of mice 50% of the offspring were grey and 50% were black. The genotypes of the parents were most likely to be:

- A. GG x Gg
- B. Gg x gg
- C. Gg x gg
- D. GG x GG

Use this information to answer questions 7 and 8

A pure breeding red flowered snapdragon was crossed with a pure breeding white flowered snapdragon. The F1 generation all had pink flowers.

Question 7

What would be the phenotypic ratio of the F2 generation?

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

Question 8

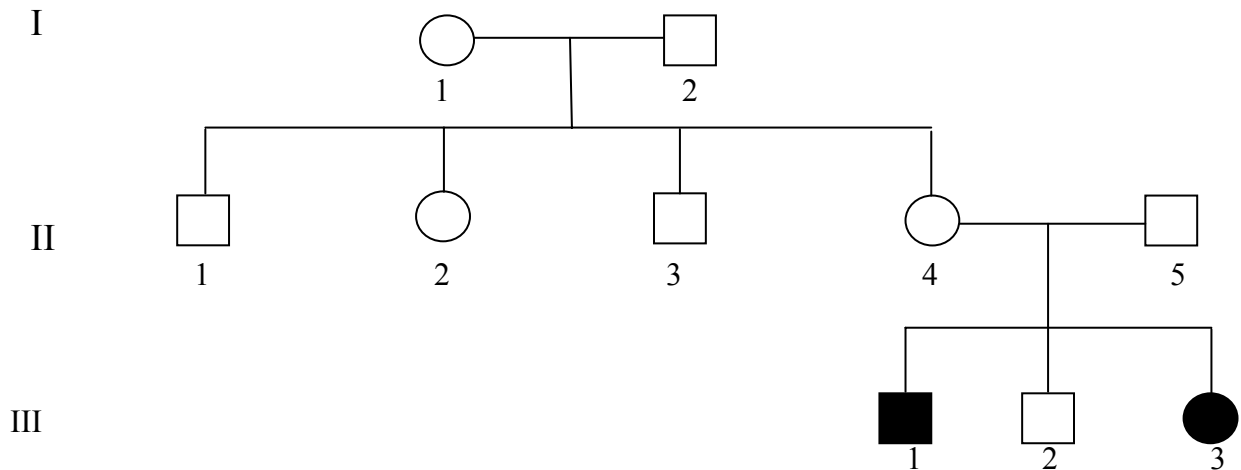
What kind of heredity is occurring in this example?

- A. Codominant inheritance
- B. Dihybrid cross
- C. Incomplete inheritance
- D. Monohybrid cross

SECTION A - continued

Use the following data to answer questions 9 and 10

A common trait observed in fruit flies is body colour. Wild type flies are brown in colour and mutant flies are black. The pedigree chart below shows the inheritance of body colour in 3 generations of fruit flies. The shaded individuals have black bodies.



Question 9

The mode of inheritance for this trait is:

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

Question 10

What is the chance of individual III-2 being heterozygous?

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

SECTION A - continued
TURN OVER

Question 11

A pair of genes are said to be linked when:

- A. They are derived from a common ancestor
- B. The genes are homologous
- C. The genes assort independently during meiosis
- D. The genes are located on the same chromosome

The table below shows the recognition sequences of 4 restriction enzymes.

ENZYME	SOURCE	RECOGNITION SEQUENCE	CUT SITE
EcoRI	<i>Escherichia coli</i>	5'GAATTA 3'CTTAAG	5' G AATTC 3' 3' CTAA G 5'
BamHI	<i>Bacillus amyloliquefaciens</i>	5' GGATCC 3' CCTAGG	5' G GATCC 3' 3' CCTAG G 5'
HindIII	<i>Haemophilus influenzae</i>	5' AAGCTT 3' TTCGAA	5' A AGCTT 3' 3' TTCGA A 5'
Sau3A	<i>Staphylococcus aureus</i>	5' GATC 3' CTAG	5' GA TC 3' 3' CT AG 5'

Question 12

If a scientist wished to cut a piece of DNA into smaller fragments, which of the 4 enzymes would be the worst choice to use?

- A. EcoRI
- B. BamHI
- C. Hind III
- D. Sau3A

Question 13

Polymerase chain reaction (PCR) is a common technique used in the field of Molecular Biology. Which natural cellular process is mimicked by performing PCR?

- A. DNA replication
- B. Protein synthesis
- C. Transcription
- D. Mitosis

SECTION A - continued

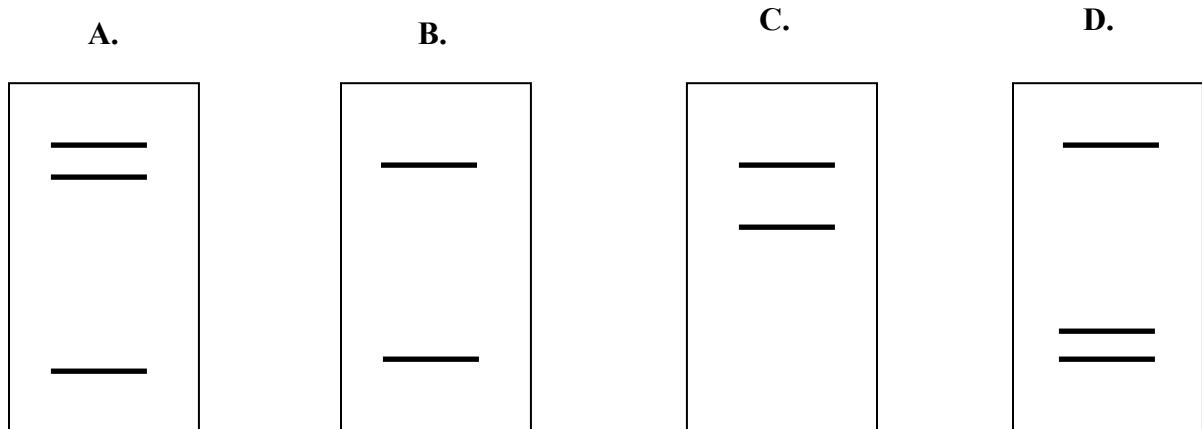
Question 14

The diagram below shows the location of restriction enzyme recognition sites on a fragment of DNA 500bp long.



After the fragment was digested with the enzyme, the resultant pieces of DNA were loaded into an electrophoresis gel.

Which of the following diagrams shows the expected band pattern on the gel?



Use this information to answer questions 15 to 17

The table below shows the change in frequency of a single allele in a population over a period of 20 generations.

	Generation 1	Generation 20
Genotype aa	10	80
Genotype Aa	70	10
Genotype AA	20	10

Question 15

A possible explanation for this change would be that over time there was:

- A. A decrease in the adaptation of allele a
- B. An increase in the adaptive value of allele a
- C. A increase in the population number of the organism
- D. A favourable mutation occurred

SECTION A - continued
TURN OVER

Question 16

The cause of the change in frequency of the alleles is most likely to be due to:

- A. Genetic drift
- B. Founder effect
- C. A mutation
- D. Random mating patterns

Question 17

If the frequency of the alleles for both traits had remained constant over the 20 generation period what effect would this have on the population?

- A. Evolution would not have occurred in the population
- B. The recessive trait would increase in frequency
- C. The dominant trait would increase in frequency
- D. The frequency of both traits would remain stable

Question 18

Wild type fruit flies have straight wings. As a result of a mutation some flies have developed curly wings. In an experiment flies developed straight wings if kept at 25°C, but developed curly wings if kept at 35°C. This might occur because:

- A. The wing type phenotype is influenced by environmental factors
- B. Fruit flies are unable to survive at high temperatures
- C. High temperatures increase the rate of mutations
- D. Straight winged flies are unable to breed at 35°C

Question 19

Which of the following rocks would be the most likely to contain fossils?

- A. Glacial ice from 10000 years ago
- B. Sedimentary rocks that are 50 million years old
- C. Volcanic rocks that are 20 million years old
- D. Amber that is 10 million years old

SECTION A - continued

The diagram shown below represents several layers of undisturbed rock strata.

Fossil of organism A
Fossil of organism B
Fossil of organism C

Question 20

Which of the following best described the relationship between these organisms?

- A. Organism A is the direct ancestor of organisms B and C
- B. Organism C was present in greater numbers than organism B
- C. Organism C is the most structurally advanced
- D. Organism B is more recent than organism C

Question 21

An insecticide was developed with a view to killing off mosquitoes. Initially the insecticide was very effective, however its efficacy decreased over time. The increase in insecticide resistance in mosquitoes supports the concept that:

- A. Species numbers tend to remain constant
- B. The application of toxins always causes advantageous mutations
- C. Organisms with a favourable phenotype tend to survive and reproduce
- D. When an environmental changes so does the allele frequencies in the population

Question 22

When Darwin visited the Galapagos Islands he carried out studies on the finches that he found there. He noted a wide range of finch species and particularly many differences in their beak structure. These differences are due to:

- A. The small size of the Galapagos Islands
- B. Different mating behaviours in the finch species
- C. Population isolation and subsequent adaptation to different environments
- D. Characteristics acquired by parent finches during their life time subsequently passed on to their offspring

SECTION A - continued
TURN OVER

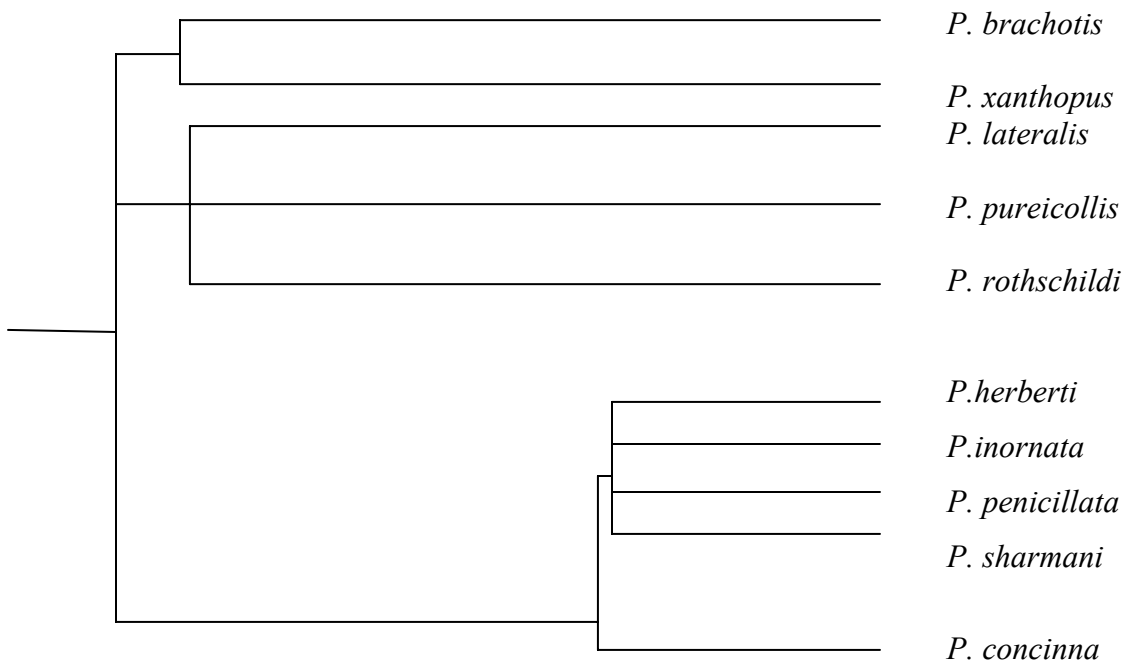
Question 23

DNA hybridisation is a technique which involves single strands of DNA from different organisms being annealed to each other and then heated to determine the strength of the bond between the strands. This amount of heat is measured and used to determine:

- A. How long ago two species shared a common ancestor
- B. The extent of relatedness between 2 different species.
- C. Whether the chromosomes are homologous pairs or not
- D. The extent of similarity between two polypeptides

Question 24

The Rock-wallabies (*Petrogale* spp.) is the most diverse genus of living macropods consisting of 16 species and several sub species. An analysis of the cytochrome b protein was performed on a range of organisms in the *Petrogale* genus. This information was then used to produce the following cladogram.



Which of the following conclusions can be made using this data?

- A. All members of the *Petrogale* genus have analogous features.
- B. *P. brachotis* and *P. concinna* do not share a common ancestor
- C. *P. herberti* and *P. inornata* have a greater genetic similarity than *P. brachotis* and *P. rothschildi*
- D. The similarity of these organisms must be due to adaptive radiation

SECTION A - continued

Question 25

Which of the following statements about prokaryotic chromosomes and eukaryotic chromosomes is most correct?

- A. Both types of chromosomes are located in membrane bound structures.
- B. Both types of chromosomes are arranged in homologous pairs
- C. Prokaryotic chromosomes are circular and eukaryotic chromosomes are linear
- D. Prokaryotic chromosomes are made up of chromatin and eukaryotic chromosomes are not.

**END OF SECTION A
TURN OVER**

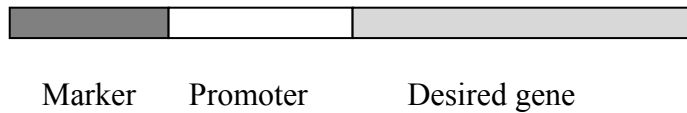
SECTION B**Instructions for Section B**

Answer all questions in the spaces provided.

Question 1

A company wishes to insert a gene to increase the vitamin A content in a rice crop.

Many people believe it is just a matter of taking a gene from one organism's genome and inserting it into another. However, the construct (genetic information) being inserted is shown below.



Plant cloning in plants is often performed using *Agrobacterium tumefaciens*, a bacterium that naturally inserts genetic material into plants.

The construct is inserted into a ti plasmid which is taken up by the bacterium. Plant cells are then exposed to the bacterium. The ti plasmid moves into the plant cell and inserts DNA into the plants chromosomes. Single cells are then used to produce a line of transgenic plants.

- a. What term is used to describe the role of the bacterium in this process?

_____ 1 mark

- b. Explain the purpose of the promoter region of the genetic construct.

1 mark

SECTION B - continued

- c. It is necessary to perform a screening stage before using the plant cells to create a line of transgenic plants. Identify the section of the construct that would enable screening to occur. Briefly explain why the screening stage is necessary

2 marks

- d. What feature of the genetic code enables genetic information to be expressed after being inserted into a foreign genome?

1 mark

- e. Define the term “plasmid”.

1 mark

Total 6 marks

SECTION B - continued

TURN OVER

Question 2

Drosophila is a genus of small flies, belonging to the family *Drosophilidae*. The common name of members of this genus is fruit flies or vinegar flies.

- a. Inheritance of eye colour in drosophila flies is X linked. Wild type drosophila flies have red eyes. A mutant allele causes the flies to have the recessive white eye phenotype.

If a white eyed female fly is crossed with a red eyed male fly, establish the genotypic and phenotypic ratios of their offspring.

3 marks

SECTION B - continued

Pure breeding *Drosophila* with brown body pigmentation and long straight wings were crossed with pure breeding *Drosophila* that have ebony body pigmentation and short vestigial wings.

All of the F1 flies had brown body pigmentation and long straight wings. Flies from the F1 generation were allowed to cross producing the F2 generation which were observed. Then the number of flies of each phenotype was recorded in the table below.

F2 phenotype	Number of flies
Brown pigmentation, long wings	890
Brown pigmentation, vestigial wings	280
Ebony pigmentation, long wings	310
Ebony pigmentation, vestigial wings	85

- b. The genetic cross described above is an example of a dihybrid cross. Explain how the information supplied can be used to support this fact.

1 mark

- c. Identify a possible genotype for an F2 fly with brown pigmentation and long wings (show all working required to establish the genotype)

2 marks

SECTION B - continued
TURN OVER

- d. Predict the phenotypic ratio for the F2 generation. Compare the actual result to your predicted value; are they exactly the same or different? Explain why this occurs.

2 marks

- e. A geneticist believes that the genes for these traits are independently assorted. Outline the genetic cross that would need to be performed to prove this hypothesis and explain what the results should be if the geneticist is correct.

2 marks

Total 10 marks

SECTION B - continued

Question 3

The DNA sequence shown below codes for the initial section of a gene.

TACATAGCACCTATCAT

- a. Establish the mRNA sequence for this section of DNA.

1 mark

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

- b. Use the codon table above to establish the amino acid sequence.

1 mark

- c. Which cellular process was mimicked in the previous step?

1 mark

SECTION B - continued
TURN OVER

- d. A mutation occurred in which the 6th base in the mRNA sequence is replaced by an A. What type of mutation has occurred?

1 mark

- e. Identify the effect on this protein and explain why the mutation has this effect on the protein.

2 marks

Total 6 marks

SECTION B - continued

Question 4

The innocence project is an organisation that started in the USA. Its purpose is to assist people who have been wrongfully accused and convicted of committing a crime. The most common means involved is by the analysis of samples containing DNA which could not be previously analysed.

1	2	3	4	5	6	Crime Scene
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Suspect 1 was found holding the murder weapon at the crime scene.

When questioned they said that they had only picked up the weapon when checking the pulse of the victim. However, when this matter came to trial they were found guilty and sentenced to 20 years imprisonment.

After they had served 7 years the technology now existed to analyse some skin cells found underneath the fingernails of the victim. The DNA from these cells is marked “crime scene” in the diagram above.

The DNA from 5 other possible suspects was also analysed at the same time.

SECTION B - continued
TURN OVER

- a. Was suspect 1 wrongfully convicted? Use the information supplied to justify your answer.

2 marks

- b. Identify the technique that is used to produce genetic fingerprints such as the ones shown on the previous page.

1 mark

- c. This process relies on DNA samples being digested (cut into fragments). Identify the tool that is used to accomplish this and explain how this tool works.

2 marks

Total 5 marks

SECTION B - continued

Question 5

In 1978 a geologist, George Haas found a fossil of an organism which has since been named *Pachyrhachis problematicus*. The organism resembles a snake in that it had mobile jaws and a narrow skull that fully encloses the brain. However, the organism also resembled a lizard in that it had a pelvis and 2 fully formed rear legs. He referred to this organism as a lizard, but the scientists who later studied this organism declared it to be the missing link between snakes and giant sea lizards called mosasaurs.

- a. What is the scientific term given to “missing links” such as *P. problematicus*? What is their value when studying evolution?

2 marks

Only two *P. problematicus* fossils have ever been found, both by Haas and both in the same location. One is a complete skeleton and the other one has a crushed skull and pelvis.

- b. Although it is assumed that both fossils were of the same species, it is very difficult to prove this. Briefly explain why.

1 mark

- c. The age of the fossil is estimated at approximately 95 million years old. Identify an absolute dating technique that could be used to verify this finding.

1 mark

SECTION B – continued
TURN OVER

- d. Is it possible for the *P. problematicus* skeletons to be used as index (indicator) fossils? Justify your answer.

2 marks

It is a common practice to use fossils as the basis to reconstruct what an organism looked like as well as extrapolate information about its diet and habits. Diagram 1 shows a fossilised skeleton of *P. problematicus* and diagram 2 shows an artist's reconstruction.



Diagram 1



Diagram 2

- e. Besides the skeletal structure, explain what information scientists use to reconstruct the appearance of long extinct organisms such as *P. problematicus*.

1 mark

Total 7 marks

SECTION B - continued

Question 6

In October 2009 information was released about an organism referred to as the latest member of the ancestral humanoid family; *Ardipithecus ramidus* also referred to as “Ardi”.

The first *A. ramidus* fossils were located in the Afar rift, Ethiopia in 1992 but they were so fragile that it took a group of Scientists 17 years to reassemble the pieces and extrapolate information from them. The *A. ramidus* fossil has been dated at approximately 4.4 million years, making it considerably older than the previous oldest humanoid; the *Australopithecus afarensis* fossil known as “Lucy”.

- a. There are several theories about human evolution, which of these is supported by the discovery of fossils such as Lucy and Ardi?

1 mark

- b. Ardi had a projecting muzzle, that did not thrust forward as much as those of modern apes and the supraorbital ridge was different to that of modern humans and other primates. However, examination of the base of the skull indicates that Ardi's brain and spinal cord was positioned in a way similar to modern humans. What conclusions can be drawn about Ardi's mode of locomotion? Explain.

2 marks

- c. The current theory is that humans and other modern primates last shared a common ancestor approximately 6 to 7 million years ago. It was found that Ardi had many traits that are not found in modern day apes. Identify one appropriate conclusion that can be drawn from this information.

1 mark

SECTION B - continued
TURN OVER

- d. Geologists were able to use volcanic layers above and below the *A. ramidus* fossil in order to date it. Is this an example of relative dating or absolute dating? Justify your response.

2 marks

- e. One method of determining the degree of relatedness between 2 different species is to perform DNA hybridisation. Identify 2 reasons why it may be difficult for scientists to perform DNA hybridisation using ancient fossils such as Lucy and Ardi.

2 marks

- f. Although the “Ardi” fossil was located between two layers of volcanic rock, the fossilised remains were actually located in sedimentary rock. Explain why fossils are commonly found in sedimentary rocks but not in volcanic rocks.

1 mark

Total 9 marks

SECTION B - continued

Question 7

The use of assisted reproductive technologies such as IVF has increased by approximately 10% per year in Victoria since 2003. In 1981 nine Victorian children were born as a result of IVF. Collectively they were the 4th to 13th children in the world to be born as a result of this technique. In Victoria the numbers of children born as a result of IVF continue to increase and some of the data relating to this trend is shown below.

YEAR	NUMBER OF CHILDREN BORN
1999	595
2004	1271
2006	1671

- a. Biologists consider biological, cultural and technological evolution to be interrelated. Use the information supplied to explain the impact of this type of technological evolution on biological evolution.

2 marks

In many cases the sperm and ova used in IVF programs come from the prospective parents. However it is not uncommon for a couple to use either donor ova or sperm.

In 1992 a US doctor specialising in infertility treatments was found guilty of using his own sperm for his IVF patients and it is estimated that he fathered at least 75 children over several years.

- b. Would this doctor's action's contribute to stability or change within the gene pool of the human population he was a member of? Justify your response.

2 marks

SECTION B – continued
TURN OVER

In some cases rather than performing IVF it was also alleged that the doctor concerned injected women with the hormone human Chorionic Gonadotrophin (hCG), the hormone that is detected by the use of pregnancy kits.

- c. If a woman treated in the above manner undertook a pregnancy test what result would occur? Explain why.

2 marks

- d. It was further alleged that the socio-economic status and family background of the women involved was used to determine which women were injected with hCG and which actually underwent IVF. Identify the process that is occurring in this example.

1 mark

Total 7 marks

END OF QUESTION AND ANSWER BOOK