

Student Name: _____

Biology

Written examination 2



2006 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>	<i>Suggested times (minutes)</i>
A	25	25	25	30
B	8	8	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.
- Calculators are NOT 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 communication devices into the examination room.

SECTION A- Multiple-choice questions**Instructions for Section A**

Answer **all** questions.

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

Consider the following table showing the diploid number of chromosomes for several organisms:

Organism	Diploid number
Cat	38
Garden pea	14
Human	46
Brewer's yeast	30
Chimpanzee	48

Which organism would have a sperm cell that contains 24 chromosomes?

- A. cat
- B. human
- C. chimpanzee
- D. garden pea

Question 2

Below is a list of steps involved in DNA replication (they are not in order).

1. The DNA parent strands separate slightly
2. Two new double strands are created
3. A single stranded RNA primer attaches to a parent strand
4. DNA polymerase adds new nucleotides

The correct order is:

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

SECTION A- continued

Question 3

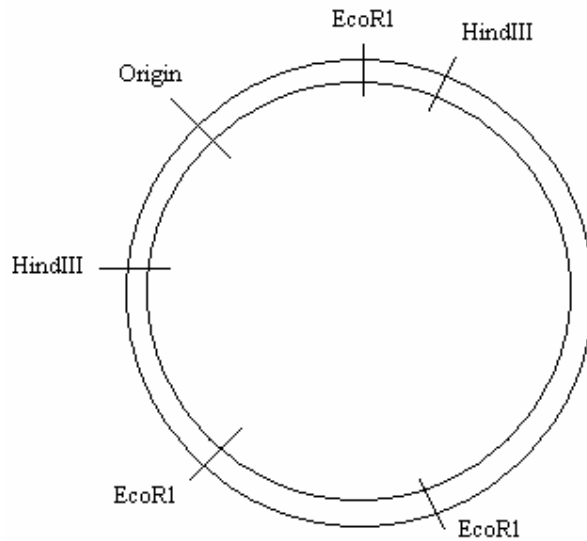
A polypeptide produced by a bacterial cell is analysed and found to contain only 12 amino acids. Normally, it would contain over 200. What is the most likely reason for this difference?

- A. Not all of the mRNA was able to reach the ribosome.
- B. A stop codon was created through a mutation in the DNA.
- C. The cell ran out of the required amino acid.
- D. The polypeptide was too long to stay together.

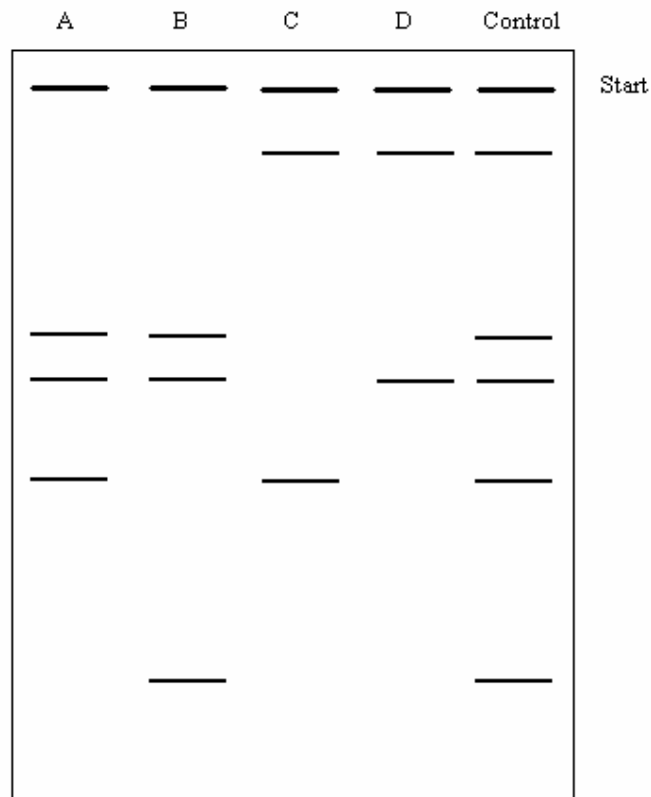
SECTION A- continued
TURN OVER

The following information is required for Questions 4 and 5.

A bacterial plasmid was isolated and sequenced. Using the restriction enzymes *EcoRI* and *HindIII*, the following points of cutting were noticed:



The pieces from this plasmid were then run on a gel using electrophoresis. A control was set up using both restriction enzymes and run against pieces from plasmids cut only with *EcoRI* and only *HindIII* and some that were mixed together.



SECTION A- continued

Question 4

Which lane corresponds to the plasmid pieces cut only with *EcoRI*?

- A. A
- B. B
- C. C
- D. D

Question 5

Which lane corresponds to the plasmid pieces cut only with *HindIII*?

- A. A
- B. B
- C. C
- D. D

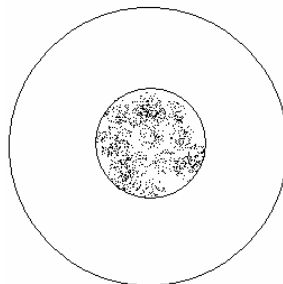
Question 6

Which of the following is not part of creating recombinant DNA using plasmids?

- A. Restriction enzymes cut the plasmid in at least one location.
- B. A foreign gene is inserted into the plasmid.
- C. DNA ligase is used to join the foreign gene and plasmid.
- D. The mixture must be subjected to high heat for the plasmid to be cut.

Question 7

The following image shows a cell during a stage of mitosis.



What stage of mitosis is this cell in?

- A. **early** anaphase
- B. interphase
- C. **late** prophase
- D. metaphase

SECTION A- continued
TURN OVER

Question 8

A mutation occurs in a gene of a sex cell of a horse. When the horse mates and produces an offspring, there are no defects detected. What type of mutation is this most likely to be?

- A. missense
- B. nonsense
- C. silent
- D. frameshift

Question 9

A student states that they 'are merely a product of their genes'. Is this statement correct?

- A. Yes. Your genome contains all of the codes for the proteins you need to become you.
- B. No. Your environment also affects your phenotype.
- C. Yes. Your environment merely allows you to show how your genes have benefited you.
- D. No. Your genome relies on environmental cues to produce all of your proteins.

Question 10

The gene for fur colour in guinea pigs has two alleles. Use the information below to answer this question:

Cross	Parents	Offspring
1	black x black	40 black
2	black x brown	36 black
3	black x brown	20 black, 18 brown
4	brown x brown	35 brown

Based on the information in this table, which of the following statements is correct.

- A. Cross 1 shows that the black fur allele is dominant.
- B. Cross 2 shows that both parents were heterozygous.
- C. Cross 3 shows that one parent was heterozygous.
- D. Cross 4 shows that the brown fur allele is dominant.

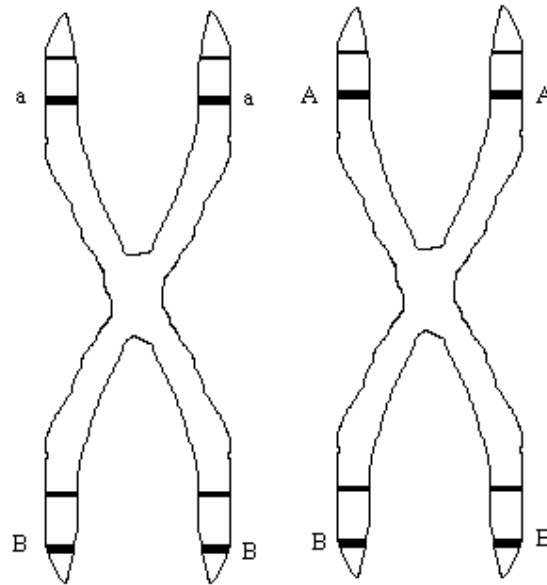
Question 11

Roan cattle are called such because they have a coat that has patches of brown on white or white patches on brown. The same species of cattle may also have brown coats or white coats. What type of inheritance is this?

- A. complete dominance
- B. codominance
- C. incomplete dominance
- D. partial dominance

Question 12

Consider the following pair of homologous chromosomes in a spermatocyte undergoing meiosis:

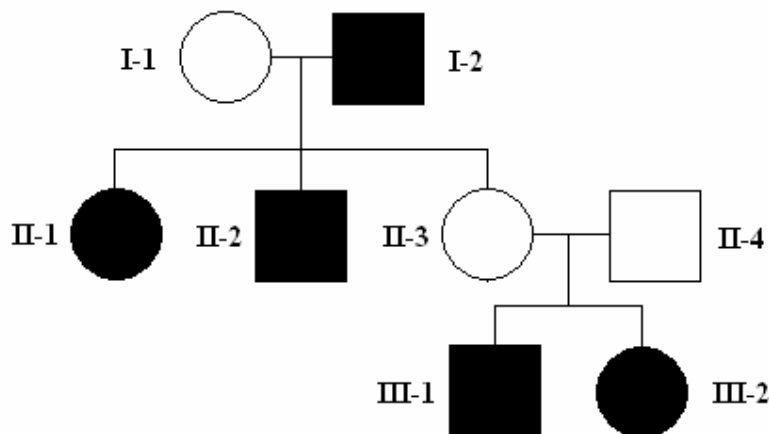


If crossing over occurred, which of the following would not be a possible allele combination found in the gametes.

- A. aB
- B. AB
- C. ab
- D. all are possible

The following information is required for Questions 13 and 14.

A pedigree chart for the genetic condition known as Marfan syndrome is shown below.



There are two alleles for the gene involved in this trait, with one dominant over the other. Let the gene be known as the Marfan gene, with M and m representing the dominant and recessive alleles, respectively.

**SECTION A- continued
TURN OVER**

Question 13

What is the genotype of individual II-4?

- A. MM
- B. Mm
- C. mm
- D. MM or Mm

Question 14

What is the chance that individuals II-3 and II-4 will have another affected child?

- A. 25%
- B. 50%
- C. 75%
- D. 100%

Question 15

Which of the following is not true about polygenic inheritance?

- A. It always involves at least two genes concerning a single trait.
- B. If you carry a mutation on one of the genes involved, you may display that mutation.
- C. The more genes that are involved, the easier it is to predict your phenotype.
- D. The genes involved may or may not be linked.

Question 16

What kind of fossils do plants tend to create?

- A. trace fossil
- B. mummified remains
- C. cast
- D. impression

Question 17

The wings of butterflies and birds are a classic example of:

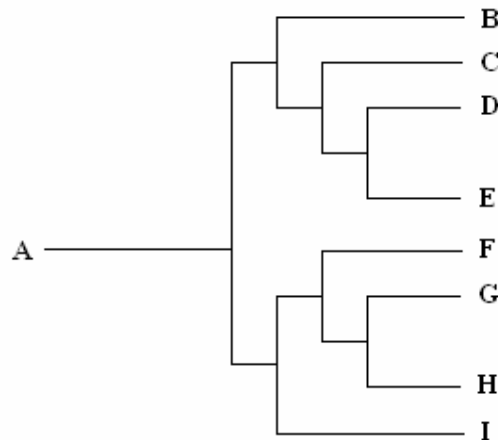
- A. divergent evolution
- B. homologous features
- C. vestigial features evolution
- D. analogous features

Question 18

Examination of various types of mammals during embryonic development shows that, at least at early stages, they all possess gill slits, aortic arches, a dorsal brain and a spinal cord. What does this suggest?

- A. All mammals have exactly the same genes as each other, but some are switched on, and others off, during development.
- B. At one stage all mammals looked alike, and convergent evolution caused changes that lead to the evolution of different modern mammal species.
- C. All mammals evolved from a common ancestor, so they still have many similarities during early development.
- D. At one stage all mammals looked different, and divergent evolution caused changes that lead to the evolution of different modern mammal species.

The following information is required for Questions 19 and 20.



Question 19

Which of the following statements is correct?

- A. B and D are more closely related than F and I
- B. D and E are more closely related than G and H
- C. F and I are more closely related than B and C
- D. D and E are more closely related than F and G

Question 20

Which of these species is the closest living species to the common ancestral species A?

- A. I
- B. C
- C. H
- D. E

**SECTION A- continued
TURN OVER**

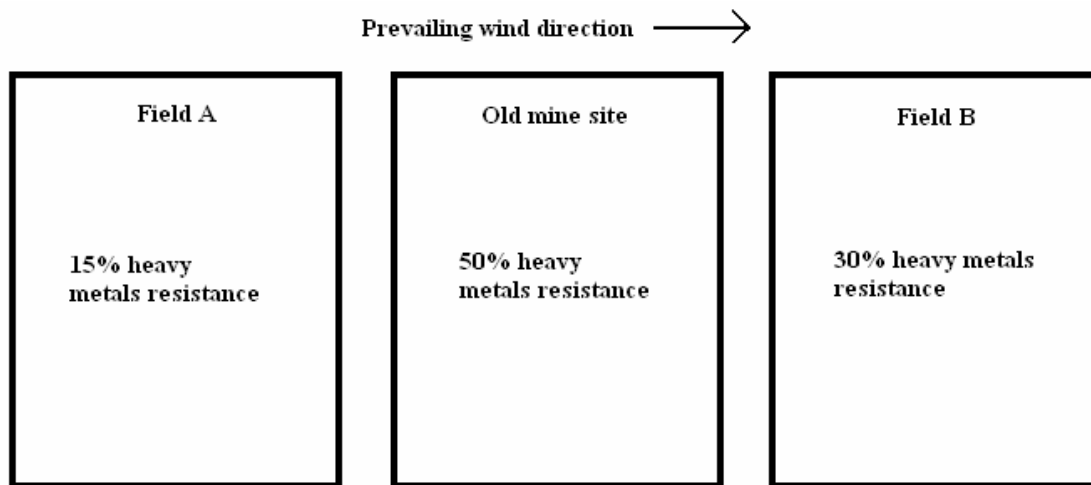
Question 21

Spacer regions are areas of DNA that do not seem to code for anything, whereas actual genes code for proteins (or parts of them). Select one of the following statements that best explain why one region may evolve faster than the other.

- A. Spacer regions evolve faster through point mutations as they can undergo changes and not affect the gene products.
- B. Genes evolve faster through point mutations as these are often silent and don't affect gene products.
- C. Spacer regions evolve faster through frameshift mutations as over 90% of DNA doesn't code for proteins (or parts of them).
- D. Genes evolve faster through frameshift mutations as this is unlikely to affect the amino acid sequence it codes for.

Question 22

An old mining site was eventually retaken by several species of plants that were able to tolerate the significant amounts of heavy metals in the soil. On either side of this area were fields that were going to be used to grow canola. An environmental scientist was called to one of the fields by the owner, as they were worried about possible contamination from the old mine site. The scientist analysed samples of plants from the mine site and from both of the adjoining fields. Their results are shown below:



Which of the following best explains this observation?

- A. Genetic drift occurred between the three sites.
- B. The wind carried seeds from the old mine site to the two fields.
- C. Gene flow occurred between the three sites.
- D. A mutation occurred at all three sites separately.

Question 23

Squirrels from the Americas and possums from Australia both share many similar features, including body size and shape, their role in food webs, and their arboreal habits. Which of the following terms best describes what has happened?

- A. Convergent evolution
- B. Divergent evolution
- C. Parallel evolution
- D. Allopatric speciation

Question 24

Which of the following explains why mules (crosses between donkeys and horses) are not able to produce offspring?

- A. The cross produced hybrid sterility in the mules.
- B. Mules are hermaphrodites (have both male and female sex organs) and are sterile as a result.
- C. The mating behaviours of mules are ineffective in attracting a mate.
- D. Mules are born without sex organs, so they cannot produce offspring.

Question 25

The human genome project produced a complete map of all of the genes found in human DNA. While scientists are still figuring out exactly what each gene is responsible for, it is becoming easier for scientists to discover the inheritance patterns of debilitating diseases, as well as for positive attributes such as increased athletic ability and attention span. In the future, it may be possible for tests to be conducted for a variety of defects/attributes using a hair or blood sample. Which of the following is the least likely outcome of this specific advance in modern medicine?

- A. Parents may start having more abortions if they find that their unborn children have certain defects.
- B. Employers may start insisting that employees with certain defects sign specific contracts, preventing them from gaining health benefits through the company.
- C. Athletes may not be allowed to participate at an elite level if they have certain defects that could mean a chance of them dying during play.
- D. Doctors will start creating designer babies for parents wishing to have a 'perfect' child.

**END OF SECTION A
TURN OVER**

SECTION B- Short-answer questions

Instructions for Section B

Answer all questions in the spaces provided.

Answer this section using a **pen**.

Question 1

A portion of a hypothetical sequence of a gene responsible for the production of the protein fibrinogen (involved in blood clotting) is presented below.

3' – T A C G C G A A A A G T C C G – 5'

- a. Complete the sequence for the complementary strand in the space above.

_____ 1 mark

- b. This section of the gene is at the beginning of a coding sequence. Use the original parent strand as a template to write down the mRNA sequence in the space below.

1 mark

- c. What is the process of producing mRNA called?

_____ 1 mark

- d. Explain what happens to the mRNA strand before it leaves the nucleus.

_____ 1 mark

SECTION B-Question 1- continued

- e. Once the mRNA strand enters the cytoplasm, it will eventually attach to a ribosome where it will be read to produce a sequence of amino acids. What is the name given to this sequence?

1 mark

Below is a codon table.

1 st position	2 nd position				3 rd position
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ileu	Thr	Asn	Ser	U
	Ileu	Thr	Asn	Ser	C
	Ileu	Thr	Lys	Arg	A
	Met (Start)	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

- f. Using the table provided, write down the amino acid sequence of the mRNA strand in question.

1 mark

- g. What is this process called?

1 mark
Total 7 marks

SECTION B- continued
TURN OVER

Question 2

Gel electrophoresis is a very powerful tool used to investigate DNA, proteins and a variety of other types of molecules. However, it is most often used with DNA fragments.

- a. Identify the property of DNA that allows electrophoresis to work.

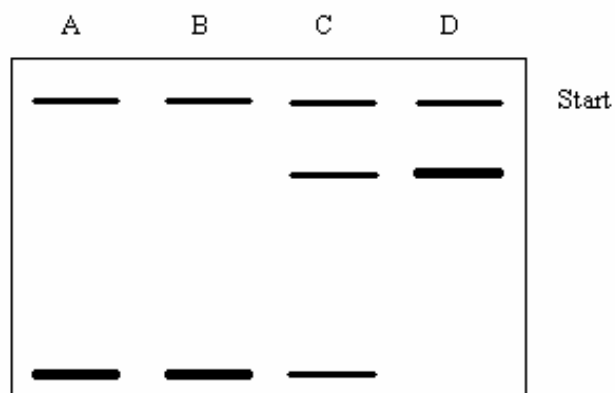
1 mark

- b. The gel used in electrophoresis is usually agarose. What is one property of this gel that allows fragments of DNA to migrate through it?

1 mark

A scientist was investigating a gene coding for a protein involved in normal neuron functioning. It was found that there were two alleles for this gene. The wild-type allele consisted of 800 base pairs (on average), but the mutant-type allele consisted of 1200 base pairs (on average). People that carried this mutant-type allele were found to have difficulty with their motor skills, and their handwriting was very shaky and erratic. The mutant allele is recessive.

A family that was believed to have at least one member that was a carrier were tested using gel electrophoresis, with the results shown below.



- c. Identify which family member(s) is/are heterozygous for the trait.

1 mark

SECTION B-Question 2- continued

BIOL EXAM 2

- d. Which family member(s) will be affected?

1 mark

- e. If family member A has a child with a homozygous recessive individual, what is the chance that their child will be affected?

1 mark
Total 5 marks

SECTION B- continued
TURN OVER

Question 3

A gene involved in a disorder known as porphyria has two alleles: one is dominant to the other. Affected individuals may have pale skin, become anaemic and not be able to tolerate sunlight. A pedigree was taken over three generations of a family with at least one affected individual. The results are written below.

Grandparents Arthur and Enid both appeared normal and had three children: Joshua, Graham and Belinda. Belinda had pale skin and had to stay indoors, but the other two children were normal. Joshua married Alice and had two children: Alexis and Diana. Alexis was anaemic and had pale skin, whereas Diana was normal. Belinda married Jackson and they had three children: Mary (normal), Chris (affected) and Steven (affected).

- a. In the space below, create an appropriate pedigree chart of the three generations of this family, including a key for reference.

3 marks

- b. State the genotypes of the following individuals and explain why they must have this genotype.

- i. Joshua

(2 marks)

SECTION B-Question 3- continued

BIOL EXAM 2

ii. Belinda

2 marks

c. State the type of inheritance that is involved. Use the given information to provide 2 pieces of evidence to justify your answer.

3 marks

Total 10 marks

SECTION B- continued
TURN OVER

Question 4

Height and flower colour in pea plants are controlled by two different genes. Each of these genes has two alleles as indicated below:

T: tall plant

F: white flowers

t: short plant

f: pink flowers

- a. A pure-breeding tall, white-flowered plant is crossed with a pure-breeding short, pink-flowered plant. Use the space below to show all working to establish the genotypic and phenotypic ratios for the offspring.

3 marks

- b. A test cross is performed using the offspring from the cross above. The results of this cross are shown in the table below. Use this information to explain if the genes for height and flower coloured are linked, or whether they will be independently assorted.

PHENOTYPE	NUMBER OF OFFSPRING
Tall, white flowered	494
Tall, pink flowered	111
Short, white flowered	108
Short, pink flowered	487

3 marks

SECTION B- Question 4-continued

BIOL EXAM 2

c. Some of the offspring of this cross were short with white flowers

i. What term is used to describe one of the offspring that is short with white flowers?

1 mark

ii. What is the genotype of the offspring that is short with white flowers?

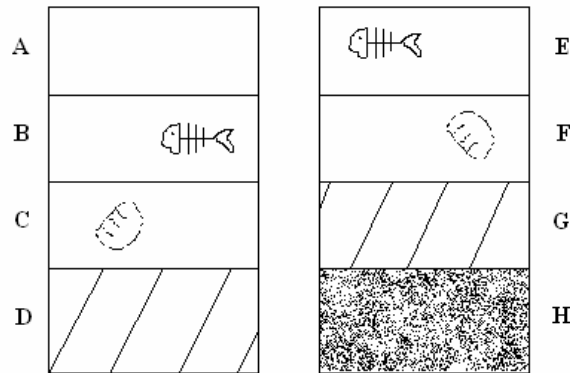
1 mark

Total 8 marks

SECTION B- continued
TURN OVER

Question 5

Two profiles have been taken from a site known for fossils, revealing several layers, as shown below:



a. Which of these is the oldest layer?

_____ 1 mark

b. Which of these is the youngest layer?

_____ 1 mark

c. The shells and fish in levels B, E, C and F are what type of fossils?

_____ 1 mark

A fossilised shell was found in the same layer as the fish, but is different to the shells in the other layers. The scientist investigating the site wants to know how old the shell is.

d. What technique can the scientist employ to determine a fairly accurate age?

_____ 1 mark

e. Is this technique always 100% accurate? Explain.

2 marks

Total 6 marks

SECTION B- continued

Question 6

A farmer sprays a field with an insecticide designed to kill fruit flies. The results are impressive, but the farmer has to spray again after a couple of months. This time, however, most flies did not seem to be killed.

a. Explain how this current population came to be insecticide-resistant.

3 marks

b. What type of selection is this?

1 mark

Total 4 marks

SECTION B- continued
TURN OVER

Question 7

A shipwreck occurred on the reef of a desert island in the South Pacific. All passengers were killed, but 20 rats that had stowed away on the boat survived. They swam to shore and began to establish themselves, as no other rats were present. The gene pool of this population is quite small compared to that of rat populations on the mainland.

- a. Identify a possible outcome for the descendents of this small gene pool.

1 mark

Initially nineteen of the rats had black fur and one had white fur. As the rats bred, an increasing number of offspring were born with white hair.

- b. What is the name of the process that is occurring with these rats?

1 mark

After about 10 years, the rat population has risen to around 1000, with 20% of them being white.

- c. Based on this information, which fur colour is dominant? Explain your answer.

2 marks

- d. After several hundred years some of the rats were returned to the mainland and they were unable to interbreed with mainland rats. What process has occurred?

1 mark

Total 5 marks

Question 8

By studying the DNA present in human mitochondria estimates about the origin of modern humans can be made. This is because of the fact that mutations tend to occur at regular rates, so analysing a wide range of humans can help provide a picture as to the actual relationships between them. There are fifteen different lineages of mitochondrial DNA in the African populations compared to only one for all other populations.

- a. Does this DNA evidence help to support the Out-of-Africa or the Parallel Evolution hypothesis? Explain.

2 marks

- b. *Homo erectus* was already throughout Asia by 200,000 years ago. Suggest what might have happened for *H. erectus* to become extinct and humans to survive.

1 mark

It is estimated that modern humans arrived in Australia between 40,000 and 100,000 years ago.

- c. How would humans have been able to come to Australia from Asia?

1 mark

- d. Humans have also evolved via non-genetic means. This is referred to as cultural evolution. State 1 form of cultural evolution that would have enhanced survival of early humans.

1 mark

Total 5 marks

END OF QUESTION AND ANSWER BOOK