

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

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

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

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

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Question 1

The nucleotide found in messenger RNA but not in DNA is

- A. uracil.
- B. adenine.
- C. guanine.
- D. cytosine.

Question 2

In a female mouse the diploid number is 40.

It is reasonable to conclude that in the mouse

- A. the chromosomes exist as homologous pairs.
- B. a skin cell will contain 20 chromosomes.
- C. during mitosis the chromosome number would be halved.
- D. at the end of meiosis there would be 10 chromosomes per cell.

Question 3

Coat colour in cats is controlled by many genes. One gene locus has many alleles, one of which is called the 'Siamese' allele (c^s). Cats homozygous for this allele have pigment only on their extremities; for example, the tip of the tail, nose, ears and feet.

When cats carry the **C** allele at this locus they have full expression of pigmentation; for example, black fur over the whole of their body.

Siamese and black cats would be produced in equal numbers in a cross of

- A. two Siamese cats.
- B. two heterozygous black cats.
- C. a homozygous black cat to a Siamese cat.
- D. a heterozygous black cat to a Siamese cat.

Question 4

In mice, two genes and their alleles are

Gene for hair colour **B** black
 b brown

Gene for hair length **L** short
 l long

These genes assort independently.

A mouse with short, black hair was crossed with a mouse with long, brown hair. Half of the resulting offspring had short hair. Half of the offspring had black hair.

The genotype of the parent mouse with short, black hair must have been

- A. **LLBB**
- B. **LLBb**
- C. **LIBB**
- D. **LIBb**

Use the following information to answer Questions 5, 6 and 7.

The colour of the fruit in a particular species of plant is under genetic control. The fruit can have three phenotypes: no colour, yellow colour or green colour. Two genes are involved in the control of fruit colour. Each of the genes has two alleles as shown.

Gene 1 **I** no colour production
 i colour is produced

Gene 2 **G** yellow fruit
 g green fruit

Question 5

These two genes are unlinked.

This means that

- A. the genes assort independently.
- B. the genes are close together on the same chromosome.
- C. there is recombination between the two genes during meiosis.
- D. particular combinations of alleles of these genes are always inherited together.

Question 6

The fruit colour of plants with the genotype **IiGg** is

- A. yellow.
- B. green.
- C. no colour.
- D. green and yellow.

Question 7

In a cross between two plants with genotypes **IiGg** and **iiGg**, the proportion of offspring with fruit

- A. with no colour is $\frac{1}{2}$.
- B. that are green is $\frac{3}{8}$.
- C. that are yellow is $\frac{1}{8}$.
- D. that are either green or yellow is $\frac{1}{4}$.

Question 8

The amount of butterfat in cows' milk is controlled by polygenes.

With respect to polygenic inheritance it is reasonable to argue that

- A. in a population each polygene has only 2 alleles.
- B. the polygenes are found on the same chromosome.
- C. the environment has no influence on the amount of butterfat in cows' milk.
- D. each polygene has a contributing effect on the amount of butterfat in cows' milk.

Question 9

Four genes found on the same chromosome are represented by R, S, T and U.

The percentage recombination between the genes is

R-T, 7%

S-T, 37%

S-R, 30%

R-U, 20%

T-U, 13%.

The sequence of genes along the chromosome must be

- A. R,S,U,T
- B. T,R,S,U
- C. U,R,T,S
- D. S,R,T,U

Question 10

Two genes and their alleles in tomatoes are shown below.

Plant height	D	tall	Fruit shape	P	spherical
	d	dwarf		p	pear-shaped

These genes are linked.

A heterozygous parent was crossed to a dwarf plant which had pear-shaped fruit and the following 100 offspring were recorded.

Tall spherical	Tall pear-shaped	Dwarf spherical	Dwarf pear-shaped
10	40	40	10

The genotype of the heterozygous parent must be

- A. $\frac{DP}{dp}$
- B. $\frac{Dp}{dP}$
- C. $\frac{Dd}{Pp}$
- D. $\frac{DD}{pp}$

Question 11

In humans the ABO blood group is controlled by a single gene with three alleles. In the ABO blood group six different genotypes and four different phenotypes are possible.

The ABO blood group is an example of

- A. the environment influencing the phenotype.
- B. discontinuous variation.
- C. polygenic inheritance.
- D. linked alleles.

Question 12

The amount of DNA in various types of chicken cells was measured. The following results were obtained.

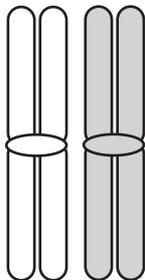
cell type	picograms of DNA
R	2.55
S	2.61
X	1.26
Y	2.54

From this data it is reasonable to conclude that the cell most likely to be a sperm is

- A. cell type R.
- B. cell type S.
- C. cell type X.
- D. cell type Y.

Question 13

During meiosis, homologous chromosomes pair as shown in the following diagram.

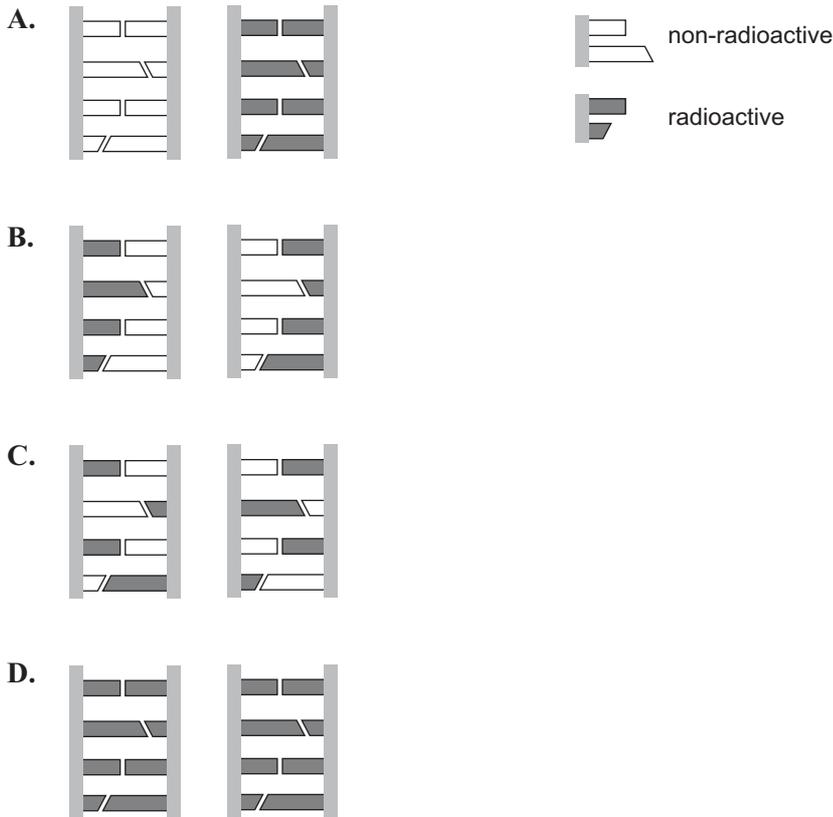


The number of DNA molecules this pair of chromosomes contains is

- A. hundreds.
- B. forty-six.
- C. four.
- D. two.

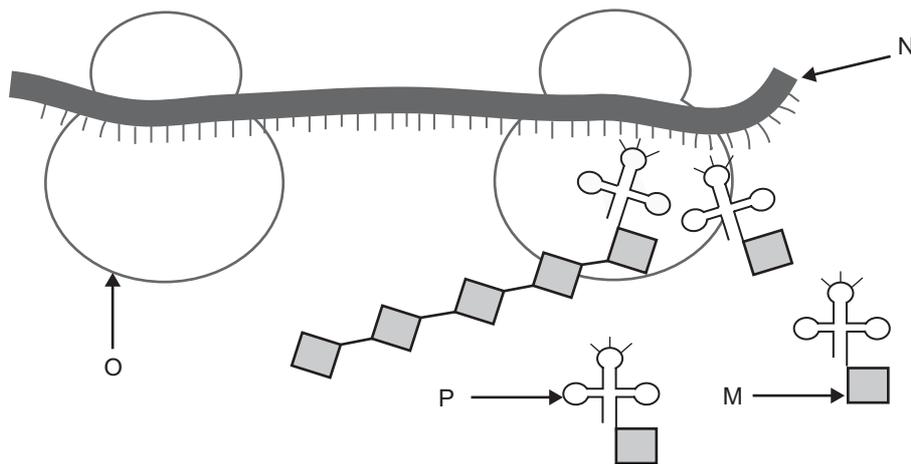
Question 14

DNA was incubated with radioactive nucleotides. After one cycle of replication the distribution of radioactive and non-radioactive nucleotides in the DNA would be



Question 15

Translation of the genetic code occurs in the cytosol of a cell. The following diagram is one representation of translation.

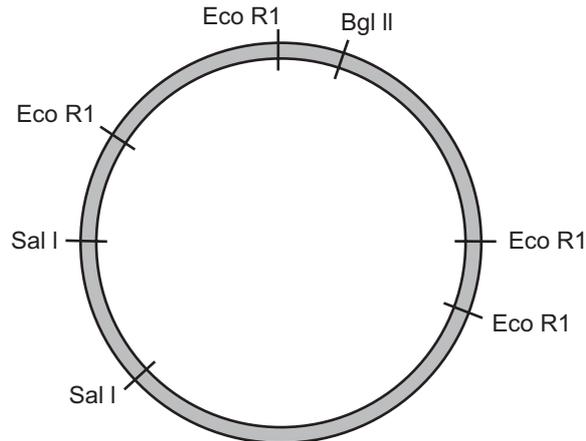


In the model presented

- A. M represents a ribosome.
- B. N represents messenger RNA.
- C. O represents transfer RNA.
- D. P represents an amino acid.

Question 16

The following diagram indicates the cutting sites of three different restriction enzymes on a particular bacterial plasmid.

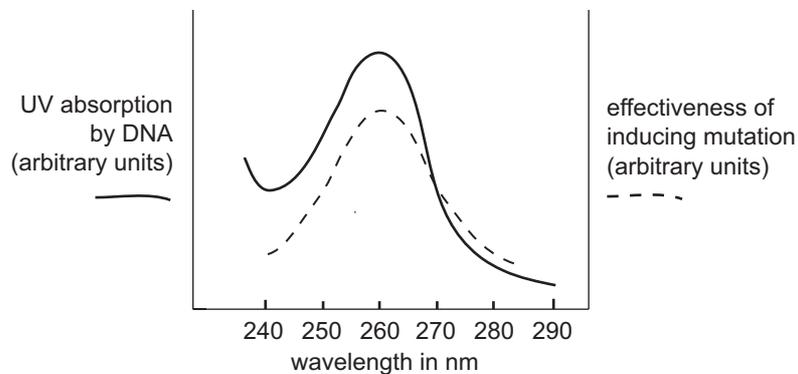


If the plasmid was incubated with the restriction enzyme *Eco R1*, the number of pieces of DNA obtained would be

- A. two.
- B. three.
- C. four.
- D. seven.

Question 17

An investigation was carried out to determine the mutation rate in DNA exposed to different wavelengths of UV light. The results are presented graphically in the diagram below.

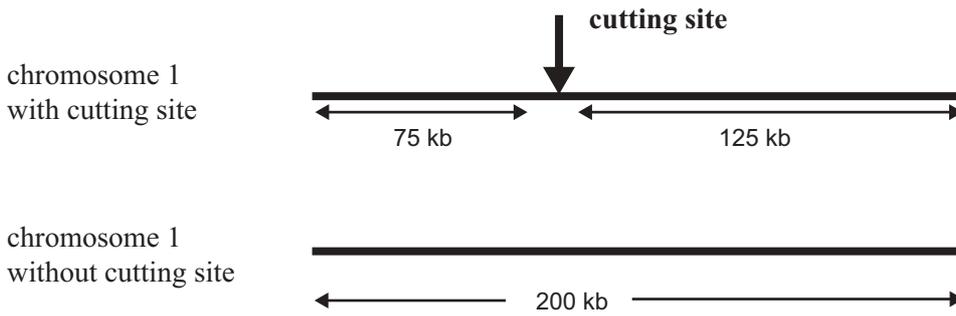


The data indicates that the wavelength of UV that produces the maximum mutation rate in DNA is

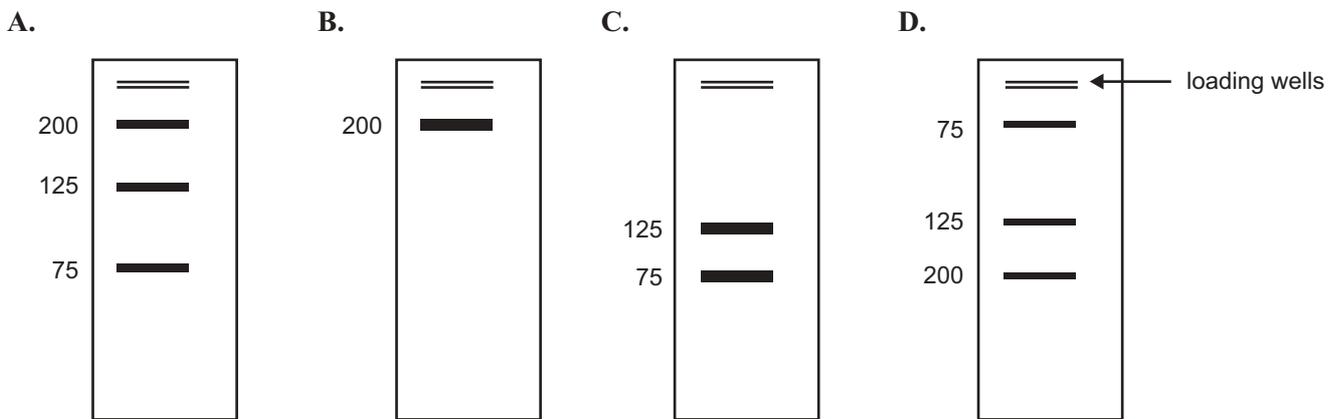
- A. 240 nm.
- B. 260 nm.
- C. 270 nm.
- D. 290 nm.

Question 18

A restriction enzyme cutting site may be present or absent in a particular 200 kb region of human chromosome 1.



The DNA of a person heterozygous for this cutting site would have the following gel pattern after digestion with the enzyme.



Question 19

Genetic drift

- A. is the result of selection.
- B. only occurs in large populations.
- C. results from a sudden increase in population size.
- D. is a chance loss of an allele from a population.

Question 20

In phlox plants (*Phlox drummondii*) a gene locus produces the enzyme alcohol dehydrogenase. There are two alleles at this locus, **A1** and **A2**, each producing a different form of the enzyme. A heterozygote can produce both forms of the enzyme.

Fifty plants were sampled to see which enzyme was produced. The results are shown below.

genotype based on enzyme produced	A1A1	A1A2	A2A2
number of plants of each genotype	20	10	20

From the data above it is possible to conclude that

- A. the total number of A2 alleles is 30.
- B. the frequency of the A1 allele is 0.3.
- C. the frequency of the A2 allele is 0.5.
- D. there are a total of 50 alleles in this population.

Question 21

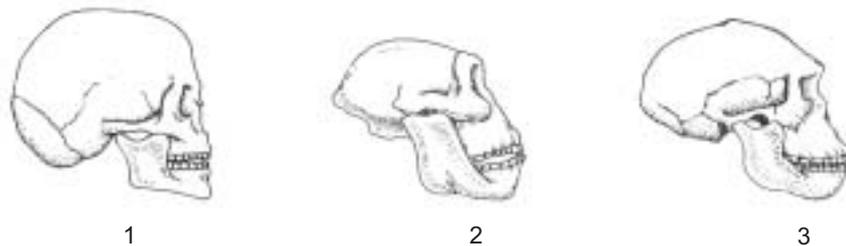
White clover (*Trifolium repens*) can be either cyanogenic, that is, it produces hydrogen cyanide; or non-cyanogenic, that is, it does not produce hydrogen cyanide. These phenotypes are under genetic control. Snails and slugs die when they eat cyanogenic plants. The cyanogenic phenotype occurs more frequently in warmer climates than in colder climates.

Based on the information above it would be reasonable to conclude that one selective pressure that would lead to a population with a low number of non-cyanogenic clover plants is

- A. grazing action of snails and slugs.
- B. availability of mineral nutrients.
- C. very low temperatures.
- D. high soil salinity.

Question 22

Consider the following diagrams of Hominid skulls.



The correct sequence of evolution, from oldest to youngest, of the Hominid species shown is

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

Use the following information to answer Questions 23 and 24.

Mesosaurus was a giant reptile that lived about 270 million years ago. The average *Mesosaurus* measured about one metre in length, had webbed feet, a long tail and numerous sharp teeth. Fossils from *Mesosaurus* have been found in only two places; the eastern side of South America and the west side of South Africa.

Question 23

Mesosaurus was most likely to be

- A. a land animal that ate plants.
- B. an aquatic animal that ate plants.
- C. an aquatic animal that ate small fish.
- D. a land animal that ate small animals.

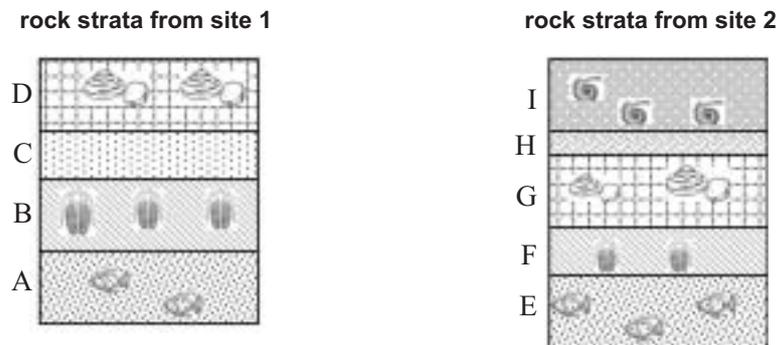
Question 24

The distribution of the fossil remains is evidence of

- A. speciation.
- B. continental drift.
- C. natural selection.
- D. divergent evolution.

Question 25

The diagrams below represent sedimentary rock strata from two different palaeontological sites.



Based on these diagrams it would be reasonable to conclude that fossils in

- A. strata B are the same age as fossils in strata E.
- B. strata A are younger than fossils in strata E.
- C. strata D are younger than fossils in strata F.
- D. strata I are older than fossils in strata G.

SECTION B – Short-answer questions**Instructions for Section B**

Answer this section in pen.

Answer **all** questions in the spaces provided.

Question 1

The Zenkey is a hybrid animal produced from a cross between a species of zebra with a diploid number of 44 and a donkey with a diploid number of 62.

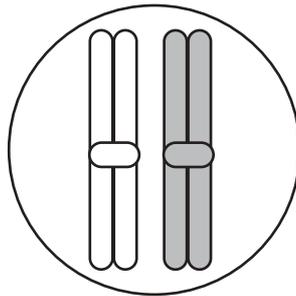
- a. What is the diploid number of the Zenkey?

1 mark

- b. By what process are gametes formed?

1 mark

- c. Starting with the cell shown below with a pair of homologous chromosomes, draw what happens to the cell and its chromosomes during the process by which gametes are produced.



3 marks

SECTION B – Question 1 – continued
TURN OVER

- d. Zenkeys are unable to produce offspring. Using your knowledge of gamete formation, suggest why the Zenkey is sterile.

1 mark

Total 6 marks

Question 2

Bay scallops (*Argopecten irradians*) have three shell colours: orange, yellow and black. It is known that the colour is under the control of one gene locus with three alleles.

- a. What is a gene locus?

1 mark

- b. If you compared the alleles of this locus at the molecular level, what would be different?

1 mark

- c. What is the name given to the process which gives rise to new alleles?

1 mark

Several crosses of scallops were carried out and the number and phenotype of the offspring were recorded. These crosses and results are shown in the table below.

Cross	Phenotypes of scallop parents	Offspring
1	yellow X yellow	27 yellow : 9 black
2	black X black	all black
3	orange X orange	30 orange : 10 black

- d. Using the allelic symbols p^Y for yellow, p^O for orange and p^b for black, show the genotypes of the parents and offspring in cross 1.

Parent's phenotype	yellow	X	yellow
Parent's genotype(s)	_____	X	_____
Offspring phenotype	yellow		black
Offspring genotype(s)	_____		_____

3 marks

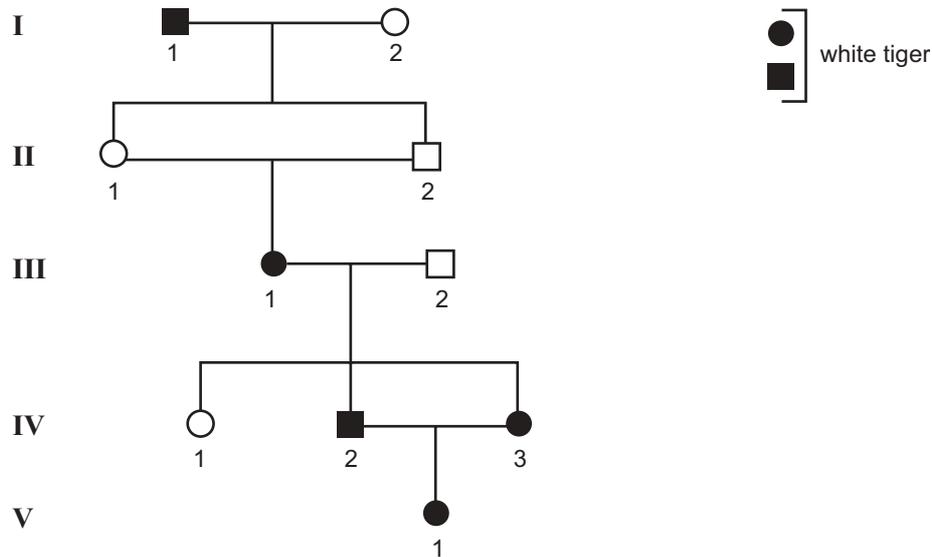
- e. What term is used to describe the genotype of the black parents and offspring in cross 2?

1 mark

Total 7 marks

Question 3

The pedigree below represents the ancestry of a white female tiger, V-1, bred in a zoo. As with domestic animals inbreeding is quite common. For example on this pedigree II-1 is mated to her brother, II-2, and IV-2 mated with his sister, IV-3.



In tigers the combination of sex chromosomes is similar to that in humans.

- a. With reference to the pedigree, explain why the locus for white coat colour cannot be
- X-linked recessive

- X-linked dominant.

1 + 1 = 2 marks

- b. Explain whether there is enough information on the pedigree to distinguish between autosomal dominant and autosomal recessive inheritance for white coat colour.

1 mark

- c. There is now a worldwide register of animals at risk of extinction. This is to avoid mating between related animals. In a conservation program, explain why avoiding inbreeding is important.

1 mark

Total 4 marks

Question 4

In corn the colour of the stem can be either wild type, which is dark green, or virescent, which is pale green.

Cross	Phenotype of parents	Temperature at which raised	Offspring
1	virescent X virescent	20°C	virescent
2	virescent X virescent	37°C	wild type
3	wild type X wild type	20°C	3 wild type : 1 virescent
4	wild type X wild type	37°C	wild type

The parents in crosses 1 and 2 had the same genotype. The parents of crosses 3 and 4 had the same genotype.

a. What conclusions can you draw

i. by comparing crosses 1 and 2

ii. from the results of cross 3 only?

1 + 1 = 2 marks

b. The genotypes of the four parents in crosses 3 and 4 are the same. Describe an experiment and its predicted results that you could use to prove that the genotypes of the four parents in crosses 3 and 4 are the same.

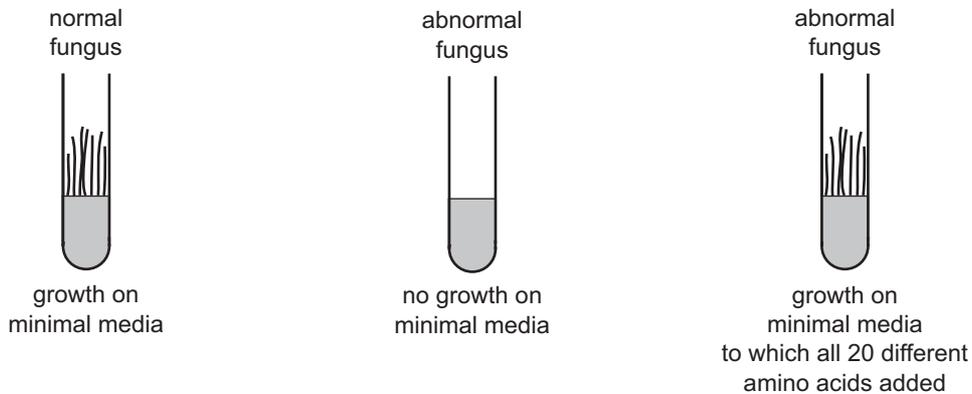
3 marks

Total 5 marks

Question 5

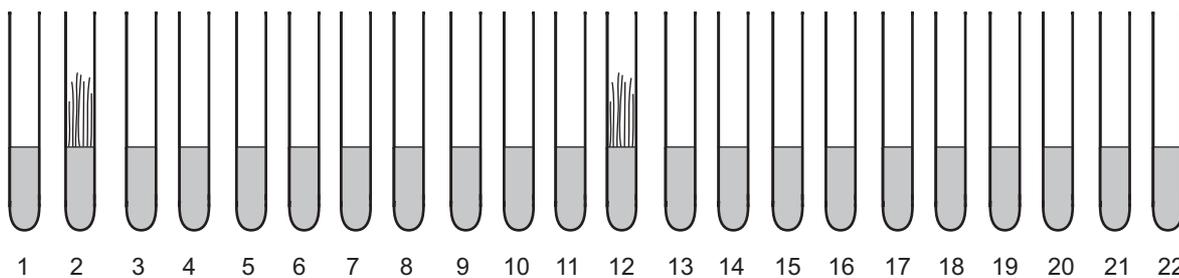
Fungi can make their own amino acids and are able to grow on a substance called minimal media.

An abnormal strain of fungus that could not grow on minimal media was discovered. The abnormal fungus was able to grow on minimal media to which all of the twenty amino acids were added. These observations can be summarised as follows.



It was assumed that the deficiency in the abnormal fungus was because of a fault in the genetic material coding for the production of one of the amino acids.

An experiment was designed to investigate which amino acid was involved. The experimental set up, involving 22 tubes, is outlined in the following diagram and the results are shown.



Tube 1 Minimal media

Tube 2 Minimal media plus all 20 different amino acids added

Tubes 3 to 22 Minimal media + one of the 20 amino acids. Each tube contained a different amino acid.

Spore of abnormal fungus was added to surface of media in each tube. All tubes were incubated under the same conditions for several days and then examined.

a. Why were tubes 1 and 2 included in the experiment?

1 mark

The diagram shows that the fungus grew in tube 12. The amino acid histidine had been added to this tube.

b. From the above experiment what two conclusions can be made about the ability of the abnormal fungus to produce amino acids?

2 marks

Consider the following genetic code table.

		Second letter				
		U	C	A	G	
First letter	U	UUU } phe UUC } UUA } leu UUG }	UCU } UCC } ser UCA } UCG }	UAU } tyr UAC } UAA stop UAG stop	UGU } cys UGC } UGA stop UGG trp	U C A G
	C	CUU } CUC } leu CUA } CUG }	CCU } CCC } pro CCA } CCG }	CAU } his CAC } CAA } gln CAG }	CGU } CGC } arg CGA } CGG }	U C A G
	A	AUU } AUC } ile AUA } AUG met	ACU } ACC } thr ACA } ACG }	AAU } asn AAC } AAA } lys AAG }	AGU } ser AGC } AGA } arg AGG }	U C A G
	G	GUU } GUC } val GUA } GUG }	GCU } GCC } ala GCA } GCG }	GAU } asp GAC } GAA } glu GAG }	GGU } GGC } gly GGA } GGG }	U C A G

- c. i. What sequences of nucleotides in DNA code for the amino acid histidine?
(Note: in the table **his** represents histidine.)

- ii. Which of the following DNA sequences could lead to the production of an uninterrupted chain of amino acids in the abnormal fungus?

sequence 1 AACGCCTCGGTGCCA

sequence 2 CAAGTAGGTACACTC

sequence 3 TAATGGACCCCGGT

Sequence _____

- iii. Explain why you made this selection in c.ii.

1 + 1 + 1 = 3 marks

During their work in establishing the structure of DNA, Watson and Crick were interested in the proportion of nucleotides in skin cells from a particular organism. They considered the results from three different laboratories. The result of each of the laboratories was as follows.

	Laboratory 1					Laboratory 2					Laboratory 3			
nucleotides in DNA	A	T	C	G		A	T	C	G		A	T	C	G
per cent	29	19	21	31		30	29	20	21		29	32	19	20

- d. Watson and Crick used the results of laboratories 2 and 3. What difference would it have made to the model they constructed of DNA had they used the results of laboratory 1 only?

1 mark

Total 7 marks

Question 6

A patient with tuberculosis had a persistent cough, fever and weakness. The patient was treated with antibiotic X and began to improve after finishing the course of antibiotics. However the cough and other symptoms returned.

- a. Explain the most likely reason why the course of antibiotics was not successful.

3 marks

Transgenic bacteria have been produced by inserting a gene or genes from another organism.

Particular species of transgenic bacteria have been developed to break down plastic compounds. Before releasing these bacteria into the environment scientists made extensive studies regarding the conditions in which the bacteria grew.

- b. Describe one important reason for this extensive study.

1 mark

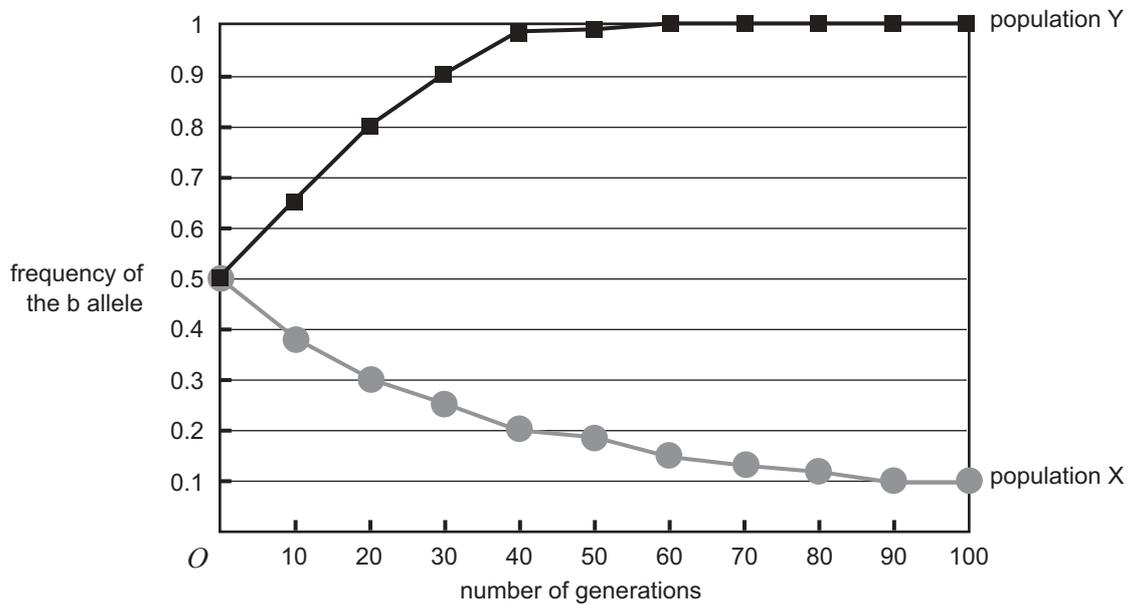
- c. What economic advantage would there be in releasing the transgenic bacteria into the environment?

1 mark

Total 5 marks

Question 7

The graph below shows changes in allele frequencies at a single locus with two alleles **B** and **b** in two very large populations. The phenotype resulting from allele **B** is the dominant phenotype. In one population there is selection against the homozygous recessive phenotype, and in the other population there is selection against the homozygous dominant and heterozygous phenotypes.



- a. In which population, X or Y, is selection occurring against the homozygous recessive phenotype? Explain your response.

1 mark

- b. Describe what has occurred in population Y by the 60th generation.

1 mark

- c. Given the results in population Y, why has a similar pattern of events not occurred in population X?

1 mark

Question 8

- a. Outline the main steps involved in the process of speciation.

3 marks

In October 2004, on the remote Indonesian island of Flores, archaeologists discovered bones from a new species of human called *Homo floresiensis*. These humans were much smaller than modern humans, with adults being about 1 metre in height and weighing around 25 kilograms. Bones from six or seven individuals have been discovered in sediments ranging in age from 94 000 to 13 000 years. The skeletons indicate that these humans had relatively long arms and a very small brain relative to body size, about equivalent to that of a chimpanzee. They had hard, thick eyebrow ridges and a sharply sloping forehead and no chin. Modern humans, *Homo sapiens*, are thought to have evolved somewhere between 55 000 and 35 000 years ago.

- b. It has been suggested that *Homo floresiensis* evolved from a population of *Homo erectus*. List two features from the fossil remains that support this view.

Feature 1 _____

Feature 2 _____

2 marks

- c. Suggest a method by which the ages of the bones of *Homo floresiensis* were estimated if found in sediments 13 000 years old.

1 mark

- d. Stone tools were found in the same sediments as the *Homo floresiensis* bones. This is an example of cultural evolution. From your studies in Biology, describe another example of cultural evolution in human populations.

1 mark

Total 7 marks

Question 9

Mammals are considered to have been extremely successful in evolutionary terms. One reason for this may be their well-developed sense of hearing.

- a. Suggest one reason why a well-developed sense of hearing would contribute to the evolutionary success of mammals.

1 mark

This well-developed sense of hearing is partly due to three tiny bones in the middle ear.

Scientists believed that the middle ear probably developed from small bones in the jaw of an early mammal. This early mammal then evolved into the three modern mammalian groups: monotremes (the platypus and echidna), marsupials (such as kangaroos) and placental mammals (such as humans, mice, gorillas).

- b. What term describes the evolution of the three mammalian groups from the early mammal?

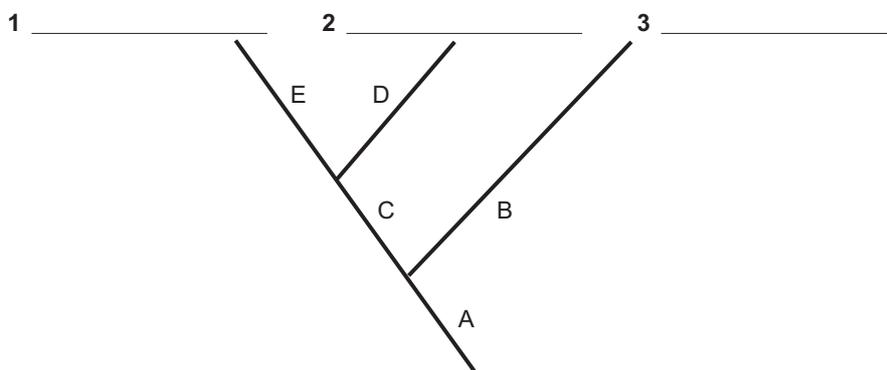
1 mark

In February 2005 scientists reported the discovery of a jawbone from *Teinolophos trusleri* that lived 115 million years ago and is thought to be the world's oldest known monotreme. It is believed that by 115 million years ago the monotremes had split off on their own evolutionary line from marsupial and placental mammals. This jawbone provides evidence that the transformation of the small bones from the jaw into the middle ear occurred independently in the two main evolutionary lines of living mammals. This supports the view that today's monotremes are a different branch of the mammalian family tree from the marsupial and placental mammals.

- c. What type of evolution describes the formation of the middle ear bones in the two mammalian lines?

1 mark

- d. In the spaces alongside 1, 2 and 3 show the possible evolutionary relationships between placental mammals, marsupials and monotremes suggested by this discovery.



1 mark

- e. Based on this discovery in *Teinolophos trusleri*, along which branches (A, B, C, D and E) in the above diagram could the lower jawbone have evolved into the middle ear?

2 marks

Total 6 marks