Trial Examination 2014

VCE Biology Units 3&4

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing: 2 hours 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Marks
A Multiple-choice	40	40	40
B Short-answer	12	12	70
			Total 110

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.

Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

No calculator is allowed in this examination.

Materials supplied

Question and answer booklet of 29 pages.

Answer sheet for multiple-choice questions.

Instructions

Please ensure that you write your name and your teacher's name in the space provided on this booklet and in the space provided on the answer sheet for multiple-choice questions.

All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet and hand them in.

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 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 best representation of a monomer, its polymer and an example of the biomacromolecules they make up is

	Monomer	**Polymer**	**Example of biomacromolecule**
A.	amino acid	protein	RNA polymerase
B.	nucleotide	DNA	ribosome
C.	amino acid	phospholipid	sphingolipid
D.	nucleotide	fatty acid	RNA

Question 2

The joining of two or more amino acids

A.   is an example of a hydrolysis reaction occurring at the ribosome.

B.   occurs inside the lumen of the endoplasmic reticulum.

C.   is the product of translation.

D.   is an example of an exergonic reaction.

Question 3

If one amino acid in a polypeptide chain changes as a result of a point mutation it will affect the

A.   primary structure of the polypeptide only.

B.   secondary structure of the polypeptide only.

C.   tertiary structure of the polypeptide only.

D.   primary, secondary and tertiary structures.

Question 4

The most accurate description of a phospholipid bilayer is that it has a

A.   polar phosphate heads facing outwards and non-polar fatty acid tails facing inwards.

B.   non-polar phosphate heads facing outwards and polar fatty acid tails facing inwards.

C.   polar phosphate heads facing inwards and non-polar fatty acid tails facing outwards.

D.   non-polar phosphate heads facing inwards and polar fatty acid tails facing outwards.

Question 5

The following diagram is of a paramecium, which is a single-celled freshwater protist. The structures labelled *P* are contractile vacuoles, which change their activity when the paramecium is faced with changes in the external concentration of solutes.
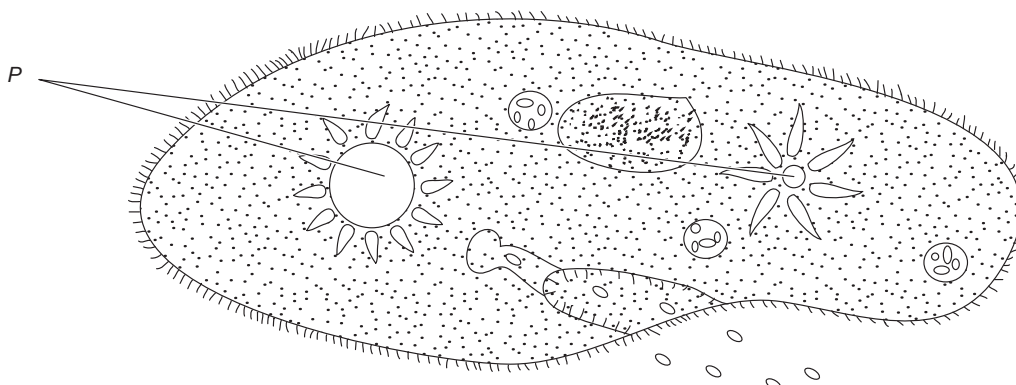
If a large amount of sea water flooded into the normal environment of the paramecium, the most likely outcome with respect to the contractile vacuole activity would be for it to

A.   increase, because the change in the external environment means it has become more hypertonic to the cytosol of the paramecium.

B.   decrease, because the change in the external environment means it has become more hypertonic to the cytosol of the paramecium.

C.   increase, because the change in the external environment means it has become less hypertonic to the cytosol of the paramecium.

D.   decrease, because the change in the external environment means it has become less hypertonic to the cytosol of the paramecium.

Question 6

The best definition enzymes is that they

A.   lower the activation energy only for catabolic reactions.

B.   have an active site that is complimentary to a variety of substrates.

C.   enable a particular chemical reaction to occur more rapidly.

D.   are always dissolved within the cytosol of a cell.
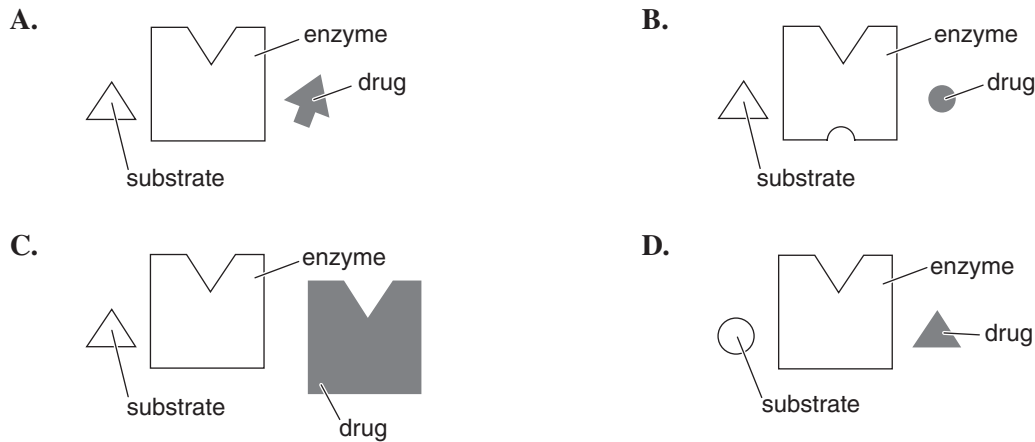
Question 7

When bread (containing starch) is eaten, digestion of the starch is aided by chewing the bread for one minute

A.   while drinking a hot cup of coffee.

B.   while drinking a cold cup of orange juice.

C.   while drinking a glass of lukewarm water.

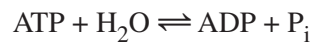**D.**   followed by preparing to swallow.

Question 8

A drug was designed to act as a competitive inhibitor for a particular enzyme that, when active, caused disease.

The diagram that best represents the action of the drug would be

A.

B.

C.

D.

Question 9

The following reaction represents the ATP cycle:

$$ATP + H_2O \rightleftharpoons ADP + P_i$$

A reasonable conclusion to make about the ATP cycle would be

A. the formation of ATP is a catabolic reaction requiring an input of energy.

B. the formation of ADP from ATP would occur while digesting fats.

C. the formation of ATP from ADP and the formation of ADP from ATP would occur in the same cellular location.

D. the formation of ATP is an example of a condensation reaction that is anabolic and endergonic.

Use the following information to answer Questions 10 and 11.

The two organelles shown below are a mitochondria and a chloroplast. Structures/areas *F* to *K* are important in the functioning of the relevant organelles.
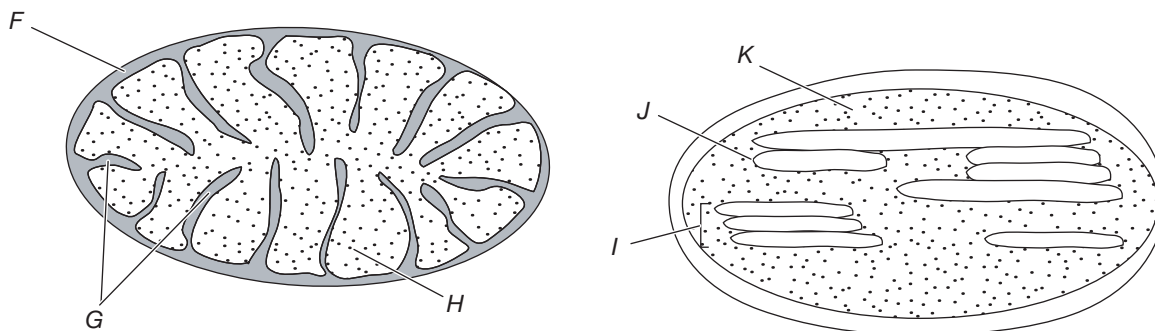
Question 10

Structures/areas *G*, *H*, *I* and *K* are respectively

A.   cristae, stroma, matrix and grana.

B.   stroma, cristae, grana and matrix.

C.   cristae, matrix, grana and stroma.

D.   stroma, grana, cristae and matrix.

Question 11

The most appropriate description of a process occurring in a particular structure would be that

A.   Kreb's cycle occurs in area *K*.

B.   the light-dependent reaction occurs in structure *J*.

C.   a low concentration of hydrogen ions occurs in area *F* during cellular respiration.

D.   the light-independent reaction occurs in area *H*.
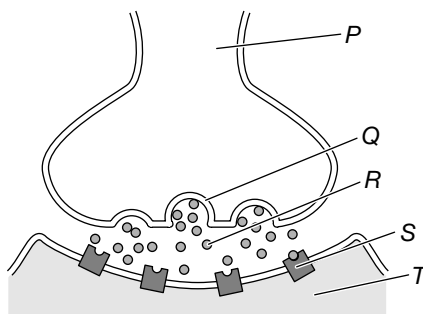
Question 12

In a typical reflex arc the effector is

A.   the central nervous system.

B.   a muscle.

C.   a sensory receptor.

D.   an action potential.

Use the following information to answer Questions 13 and 14.

The structures labelled *P*, *Q*, *R*, *S* and *T* in the diagram below represent various components of a synapse.

Question 13

The name of the process occurring at *Q* and the name of chemical *R* respectively are

A.   endocytosis and hormone.

B.   endocytosis and neurotransmitter.

C.   exocytosis and hormone.

D.   exocytosis and neurotransmitter.

Question 14

The triggering of signal transduction is best illustrated by the

A.   process of *Q* releasing chemical *R*.

B.   action potential along *P* triggering an action potential along *T*.

C.   interaction of chemical *R* with structure *S*.

D.   action potential along *T* triggering the release of chemical *R* from structure *Q*.

Question 15

Signalling molecules

A.   are examples of hormones.

B.   can be pheromones as well as steroids.

C.   always bind to receptors in the cytosol of cells.

D.   are proteins that have a variety of functions.

Question 16

Gibberellic acid (GA) is a plant hormone involved in the germination of plant seeds. If the seed in the soil is exposed to oxygen and water it will stimulate the release of GA and the seed will start to grow.

It is reasonable to conclude that a possible response of the seed to the stimulus of GA could be

A.   to activate the enzyme amylase which converts glucose to starch.

B.   reduced cell elongation.

C.   to increase the rate of photosynthesis in the seed so that glucose is available as an energy source.

D.   an increase in mitotic divisions.
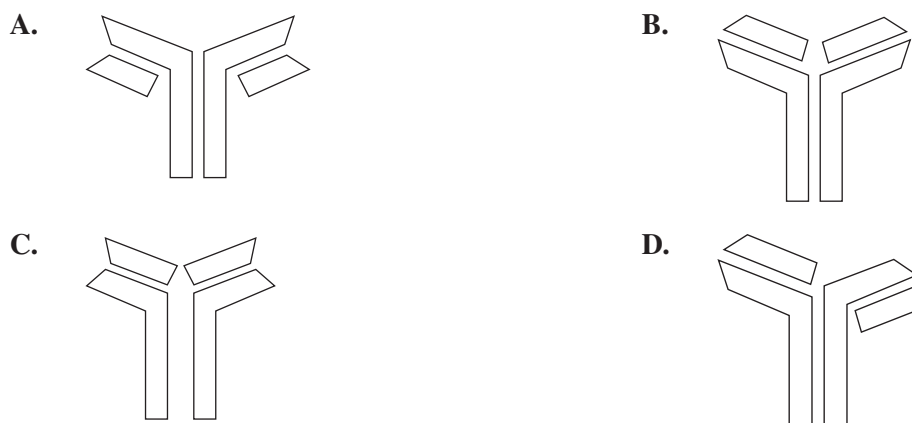
Question 17

A chemical barrier in humans that reduces the chance of a pathogen entering the body and causing disease would be

A.   unbroken skin.

B.   ciliated epithelium lining the bronchi in the lungs.

C.   food only remaining in the stomach for a short time.

D.   a lysozyme secreted from the tear ducts.

Question 18

The correct three-dimensional structure of an antibody would be

A.

B.

C.

D.

Question 19

The cell-mediated immune response involves

A.   plasma cells.

B.   B cells.

C.   helper T cells.

D.   macrophages.

Question 20

The graph below shows the incidence of gastrointestinal disease in newborn babies that have either been breast-fed or bottle-fed over the first six months of their lives.

A possible reason for the difference in the results could be

A.   breast-fed babies have been vaccinated whereas the bottle-fed babies have not.

B.   breast-fed babies obtain passive immunity from their mothers via the breast milk.

C.   the bottle-fed babies are more likely to consume milk that contains pathogens.

**D.**   the bottle-fed babies have a poorly developed immune system.

Question 21

During the cell cycle, chromosomes are visible during the

A. G2 and mitotic phases.

B. G1, S and G2 phases.

C. mitotic and G1 phases.

D. mitotic phase only.

Question 22

Semi-conservative replication of one molecule of DNA occurs as illustrated in the diagram below. This process takes place during any form of cell division.
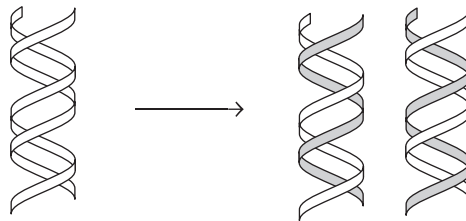
How many of the original strands would be present in the 32 cells produced after one cell divides by mitosis five times?

A. 2

B. 4

C. 16

D. 32

Question 23

When pre-mRNA is processed to mRNA

A. exons are removed, and the remaining introns have a methylated cap at the 5' end and a poly-A-tail at the 3' end.

B. introns are removed, and the remaining exons have a methylated cap at the 3' end and a poly-A-tail at the 5' end.

C. exons are removed, and the remaining introns have a methylated cap at the 3' end and a poly-A-tail at the 5' end.

D. introns are removed, and the remaining exons have a methylated cap at the 5' end and a poly-A-tail at the 3' end.

Use the following information to answer Questions 24 and 25.

The following polypeptide sequence exists in the middle of a particular protein:

Met-Val-Ser-Arg-Cys

The table below shows the codons and the appropriate amino acids they code for.

Second base in codon

		U	C	A	G	
First base in codon	**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	Ile	Thr	Asn	Ser	**U**
		Ile	Thr	Asn	Ser	**C**
		Ile	Thr	Lys	Arg	**A**
		Met	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**

(Third base in codon)

Question 24

A possible mRNA sequence for the polypeptide could be

A. AUGGUGAGUAGAUGU

B. TACCACTCATCTACA

C. AUGGUUUCCCGCUGA

D. AUGGUAAGCAGUUGC

Question 25

A mutation occurred that changed the second amino acid from Val to Leu.

The most likely change in the codon as a consequence of the point mutation is that

A. the first nucleotide in the codon would be different.

B. the second nucleotide in the codon would be different.

C. the third nucleotide in the codon would be different.

D. any of the nucleotides in the codon could be different.

Question 26

The lac operon shows how gene expression is controlled at the level of transcription. The model illustrates how bacteria, in the presence of lactose, are able to activate a gene that leads to the digestion of lactose. Once the lactose concentration is low the gene switches off. A diagram below illustrates this form of gene control when the lactose levels are high.
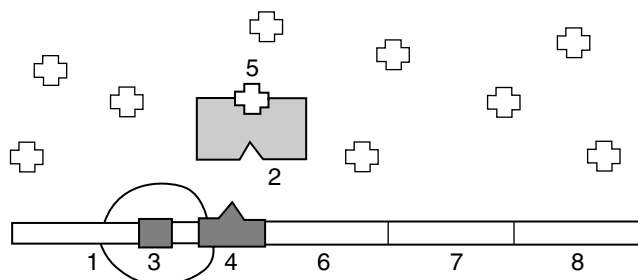
Components 1–8 are respectively

A. 1 – lactose; 2 – RNA polymerase; 3 – repressor; 4 – promoter; 5 – operator; 6,7,8 – genes

B. 1 – lactose; 2 – RNA polymerase; 3 – promoter; 4 – repressor; 5 – operator; 6,7,8 – genes

C. 1 – RNA polymerase; 2 – repressor; 3 – promoter; 4 – operator; 5 – lactose; 6,7,8 – genes

D. 1 – RNA polymerase; 2 – lactose; 3 – repressor; 4 – promoter; 5 – operator; 6,7,8 – genes

Use the following information to answer Questions 27 and 28.

There are two genes that are the most important when it comes to blood typing. One of the genes (the ABO gene) relates to surface proteins found on the surface of red blood cells and has three alleles (I^A, I^B and i). The other gene (the Rhesus gene) also relates to surface proteins found on the surface of red blood cells but it only has two alleles (R and r). The dominant form of the Rhesus gene has a positive phenotype and the recessive form has a negative phenotype.

Question 27

The genotypes possible for an individual who is blood type A positive could be

A. $I^A I^B RR$ or $I^A I^A RR$

B. $I^A I^A RR$, $I^A I^A Rr$, $I^A iRR$ or $I^A iRr$

C. $I^A I^A rr$ or $I^A irr$

D. $I^A iRr$

Question 28

Two individuals both have a phenotype of AB positive and both have Rhesus negative fathers.

The chance that these two individuals have of conceiving a child who is B negative would be

A. 0

B. $\dfrac{1}{4}$

C. $\dfrac{1}{8}$

D. $\dfrac{1}{16}$

Use the following information to answer Questions 29 and 30.

The following pedigree tracks a very rare autosomal recessive genetic disorder called galactosemia through five generations.
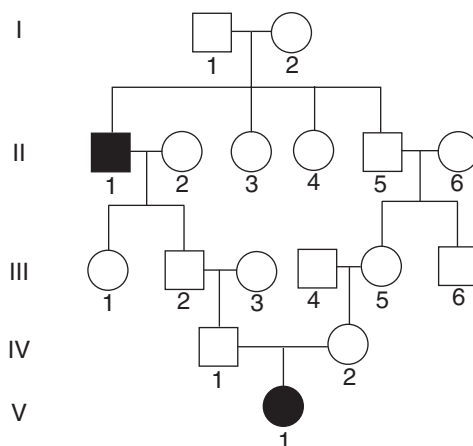
Question 29

Which individuals from the pedigree are most likely to be heterozygous?

A.   I-1, I-2, II-5, II-6, III-2, III-4, IV-1 and IV-2

B.   I-1, I-2, II-5, III-1, III-2, III-5, IV-1 and IV-2

C.   I-1, I-2, II-3, II-4, II-5, III-2, III-5, IV-1 and IV-2

**D.**   I-1, I-2, II-5, III-2, III-3, III-4, IV-1 and IV-2

Question 30

V-1 had a higher chance of expressing galactosemia than that observed in the general population because

A.   I-1 and I-2 must have been more closely related to each other compared to other members of the general population.

B.   IV-1 and IV-2 both have a $\frac{2}{3}$ chance of being heterozygous, rather than a $\frac{1}{4}$ chance if they had not had common great grandparents.

C.   individuals IV-1 and IV-2 have common great grandparents who were both heterozygous, which meant their descendants were also more likely to be carriers.

D.   recessive traits always skip generations and so it was likely to appear again at some stage.

Question 31

Several species of the genus *Akodon* encompass about 35% of the total diversity of rodents in South America. Karyotypes have been used to classify the *Akodon* genus at the species level. In the different species of *Akodon* the diploid chromosome number ranges from $2n = 9$ or 10 to $2n = 52$, with the majority of the members of this genus being characterised by relatively low chromosome numbers. The diagram below shows the distribution pattern of some of the groups.
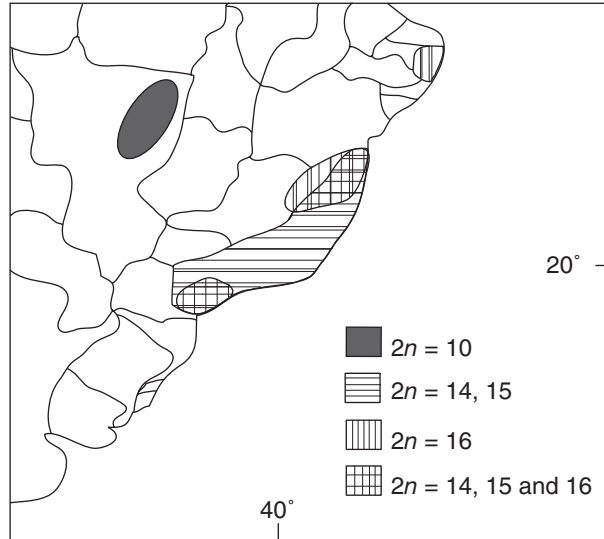
A reasonable conclusion to make based on the information provided would be

A. the species of *Akodon* with a diploid number of 10 are geographically isolated from the other groups.

B. no gene flow would occur from the species of *Akodon* with a diploid number of 16 to any other group.

C. if the species of *Akodon* with a diploid number of 10 migrated to the area that only contained species of *Akodon* with a diploid number of 16, hybrid offspring would be produced.

D. there are four species case studied in this example.

Question 32

The factor that would most likely affect the gene pool of a population would be

A. a reduced population size.

B. a change in the environment the population was exposed to.

C. a more successful reproduction rate due to increased resources.

D. exposure of the population to a mutagen.

Question 33

Fossilisation is an unlikely event; however, occasionally when organisms die, they fall into an environment that is conducive to excellent fossilisation.

The circumstances that would lead to the most effective fossilisation would be

A. rapid burial in an oxygen-rich environment.

B. rapid burial in an anaerobic environment.

C. rapid burial in an anaerobic environment free of scavengers.

D. an anaerobic environment free of scavengers.

Question 34

There is clear evidence of the existence of marsupials from 110 million years ago. Most of them are terrestrial animals that are mainly located in Australia but some are also found in South America.

The most likely reason for their existence on both of these continents is

A.   marsupials evolved independently on both continents.

B.   due to competition for resources, marsupials swam from South America to Australia.

C.   marsupials evolved before Gondwanaland started to break apart.

D.   the marsupials migrated from one continent to the other during an ice age when land bridges between them existed.

Question 35

The following data represents the number of nucleotides that are different in the cytochrome *c* gene of four different organisms:

Organism	Human (*H*)	Rat (*R*)	Mouse (*M*)	Chicken (*C*)
Human (*H*)	0	34	31	58
Rat (*R*)	34	0	9	53
Mouse (*M*)	31	9	0	53
Chicken (*C*)	58	53	53	0

The most accurate unscaled phylogenetic tree that can be constructed using this data would be
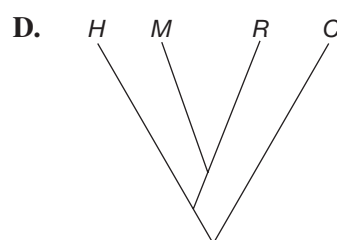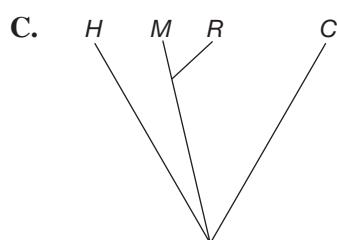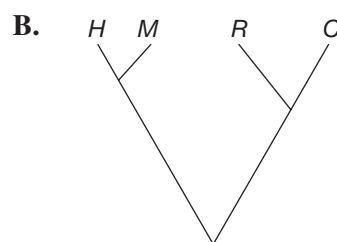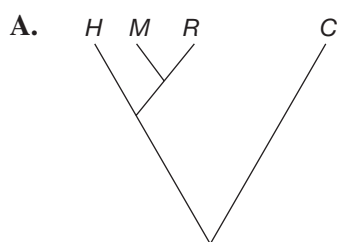
Use the following information to answer Questions 36 and 37.

The evolution of some vertebrates is illustrated in the diagram below. The width of the lines are proportional to the number of genera of that particular group that existed at the specific time.
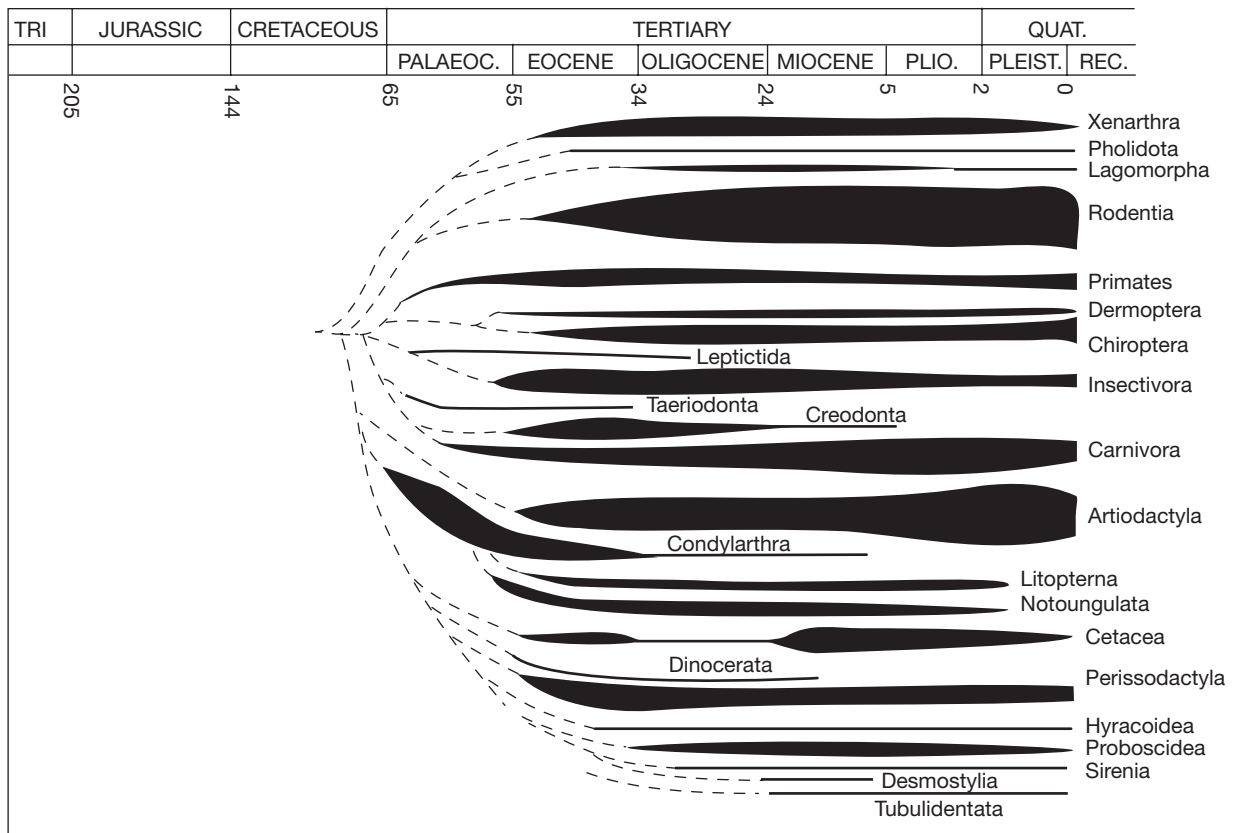
Question 36

The number of extinct evolutionary groups of vertebrates is

A. 1

B. 2

C. 7

D. 8

Question 37

Between 34 million years ago and 55 million years ago

A. primates did not change.

B. Condylarthra underwent convergent evolution.

C. rodents underwent significant divergent evolution.

D. the number of genera of carnivores remained reasonably constant.

Use the following information to answer Questions 38 and 39.

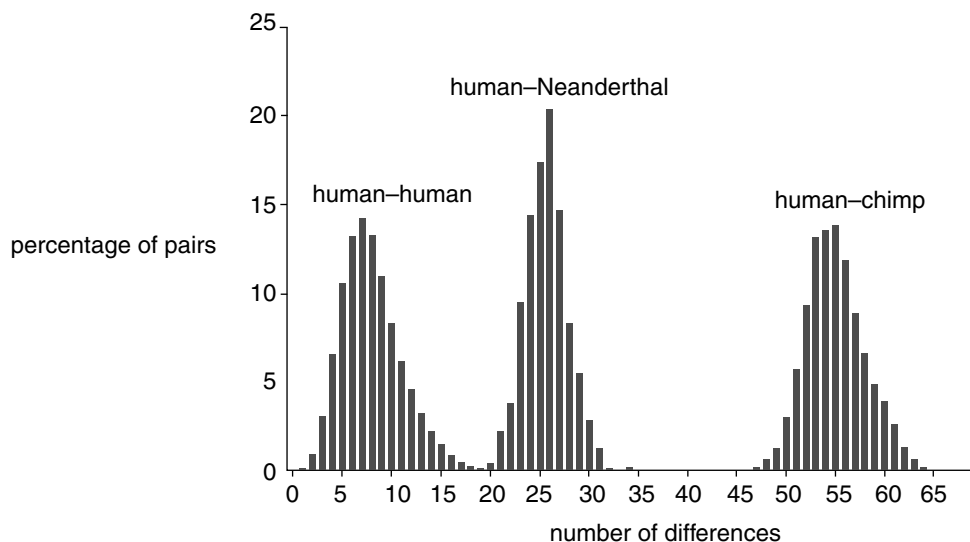In an effort to more accurately classify them, strands of DNA from *Homo sapiens* (humans), *Homo neanderthalensis* (Neanderthals) and *Pan troglodytes* (chimpanzees) were extracted and hybridisation studies were carried out comparing the three different organisms. The data generated is displayed in the graph below.

Question 38

The percentage of pairs that displayed 25 differences between the human and the Neanderthal was

A.   14%

B.   20%

C.   17.5%

D.   5%

Question 39

The data provided more evidence that suggested the human and the Neanderthal should continue to be classified as separate species.

This is due to

A.   very little overlap between the human–human and the human–Neanderthal data.

B.   the human and the Neanderthal being geographically isolated from each other.

C.   the human, Neanderthal and chimpanzee data being different when compared to each other.

D.   the percentage of pairs of the tested group that illustrated more than twenty differences was higher with the human–Neanderthal hybridised group when compared with the human–human group.

Question 40

The somatic cell gene therapy of severe combined immunodeficiency (SCID) is one of the success stories of this new technology. An adenosine deaminase (ADA) gene was successfully cloned and inserted into a viral vector. The vector (2) was mixed with isolated T cells (1) and the modified cells (3) were re-implanted back into the SCID sufferer (4), where the gene was expressed and, in some cases, the symptoms of the disease were reduced.
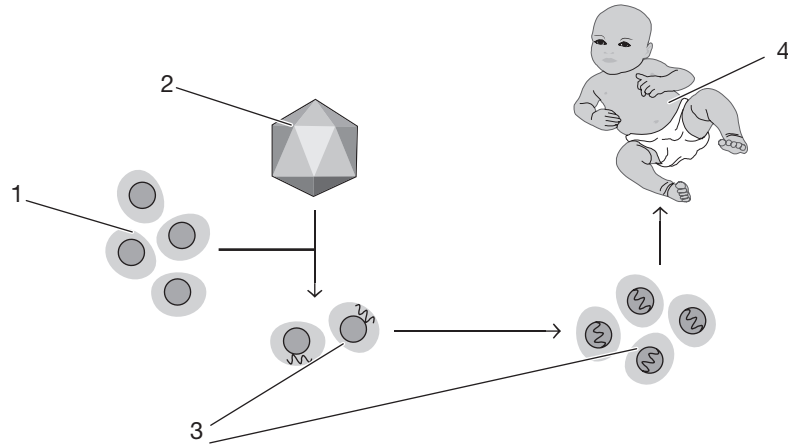
This type of gene therapy would

A.   not be passed on to the next generation.

B.   be an example of biotechnology affecting our biological evolution.

C.   provide a better prospect of curing disease rather than stem cell therapy.

D.   provide a functional gene only to those initially isolated T cells.

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer **all** questions in the spaces provided. Write using black or blue pen.

Question 1 (6 marks)

Membranes serve a very important function for cells and organelles. Studies have been carried out investigating various factors that contribute to membrane fluidity.

a. State two functions of membranes and explain the importance of each function. 2 marks

_____

_____

_____

_____

An experiment measuring the effect of temperature on the fluidity of membranes was carried out. The fluidity can be determined using electron spin resonance (ESR), which measures how well the components of the membrane stick together. Results for this experiment are graphed below.
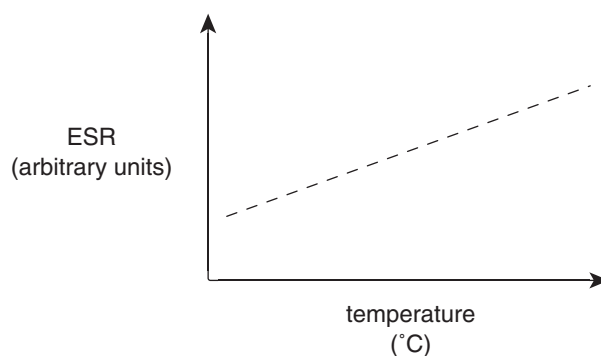
b. Use the graph to explain why membranes have an optimum temperature in which they function most effectively. 2 marks

_____

_____

_____

Cholesterol is an important component of membranes and contributes to their fluidity as a result of fitting between the fatty acid tails of the phospholipids. An experiment was done comparing the proportion of cholesterol in two species of salmon (Arctic and Pacific). It was found that the Arctic salmon had proportionally more cholesterol in their membranes compared to the Pacific salmon exposed to more temperate conditions.

c. **i.** What type of biomolecule is cholesterol? 1 mark

_____

ii. Explain why Arctic salmon have proportionally more cholesterol in their membranes. In your answer make a statement that links the temperature, membrane fluidity and amount of cholesterol. 1 mark

_____

_____

_____

Question 2 (9 marks)

Ribulose-1,5-bisphosphate carboxylase (RuBisCO), is an enzyme involved in the first major step of carbon fixation, a process by which atmospheric carbon dioxide is converted by plants to energy-rich molecules such as glucose.

a. Where within a cell is RuBisCO synthesised? 1 mark

_____

The reaction catalysed by RuBisCO is illustrated below:

$$\text{ribulose-1,5-bisphosphate + carbon dioxide + water} \xrightarrow{\text{RuBisCO}} \text{glycerate-3-phosphate}$$
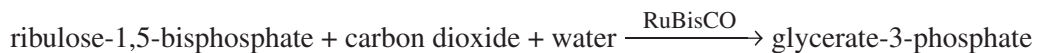
b. For carbon fixation to be completed and glucose to be formed, name the two other important reactants (other than RuBisCO and about ten other enzymes) that are required. 2 marks

Reactant 1: _____

Reactant 2: _____

RuBisCO functions most effectively at a pH of 9.

c. Design an experiment using a purified sample of RuBisCO that would test the effect of pH on it. In your answer be sure to mention the independent variable, the dependent variable and at least two controlled variables. 3 marks

_____

_____

_____

_____

_____

_____

In a photosynthetic plant cell there are many other chemical reactions occurring as well. One of these reactions converts glucose into glucose-6-phosphate, the first step of glycolysis.

d. **i.** In the light microscope diagram of a typical photosynthetic cell below, show where glycolysis occurs. 1 mark
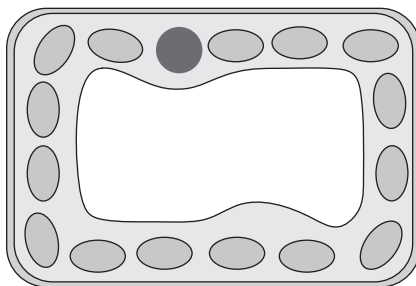
    ii. State the conditions the plant would need to be exposed to for carbon fixation as well as glycolysis to be occurring at the same rate. Explain your answer. 2 marks

_____

_____

_____

Question 3 (5 marks)

The diagram below represents an experiment conducted where aerobically respiring seeds were exposed to a variety of temperatures. The potassium hydroxide absorbs carbon dioxide and the absorbance was measured by calculating the distance (in mm) that the water moves along the tube.

tube

potassium
hydroxide

respiring
seeds

conical flask
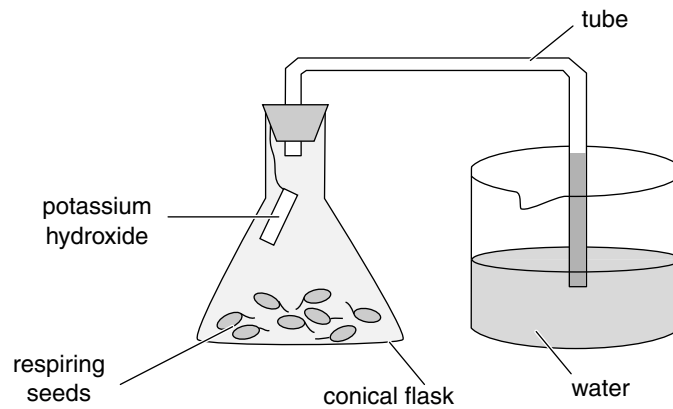
water

The results after fifteen minutes are tabulated below.

Temperature (˚C)	Distance water moves along the tube (mm)
5	3
20	55
40	53
60	32
80	1

a. Write out the balanced equation for aerobic respiration. 2 marks

_____

_____

b. Explain why water moves along the tube. 1 mark

_____

_____

c. In terms of enzyme structure and function, explain the result at 20˚C. 2 marks

_____

_____

_____

Question 4 (6 marks)

The action of hormones such as testosterone and glucagon on muscle development has been well documented. The table below shows some of the properties of both of these hormones.

Hormone	Type of hormone	Action of hormone	Response
testosterone	steroid	activates genes	more muscle protein
glucagon	protein	activates glycogen phosphorylase	more glucose available

For muscle cells to respond to these external signals they must be able to detect them.

a. Compare the different modes of detection a muscle cell would have for each hormone. 2 marks

_____

_____

_____

Once both hormones are detected by the muscle cell a response occurs. The pathway between detection and a response is known as signal transduction.

b. Discuss signal transduction with respect to glucagon. 2 marks

_____

_____

_____

Glucagon works much quicker and is shorter lasting than the action of testosterone.

c. Provide an explanation for the variation in speed and duration of action of both of these hormones. 2 marks

_____

_____

_____

Question 5 (6 marks)

Allergic reactions are becoming more common. An allergen is normally a harmless substance in the environment that an individual's immune system will recognise as foreign. The diagram below shows the steps involved in this initial reaction.
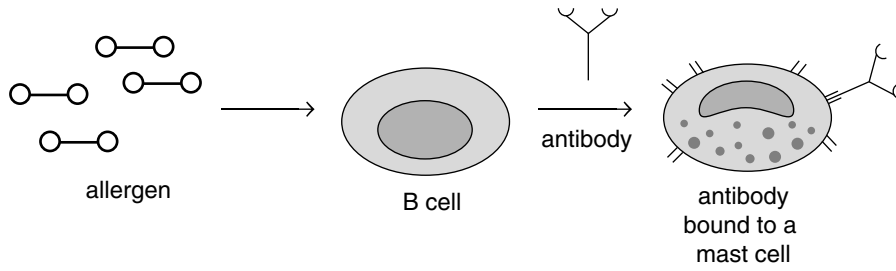
a.   Describe events that occur after the initial contact between the allergen and a B cell.   2 marks

_____

_____

_____

Once the antibodies are attached to a mast cell they cluster in areas where the allergen is likely to enter the body in the future. When the individual is exposed to the allergen again, an allergic reaction occurs. The diagram below illustrates the role the mast cell plays in this response.
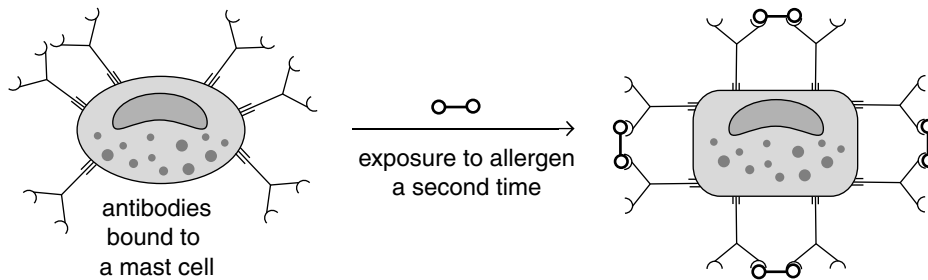
b.   **i.**   Discuss the action of the mast cell when exposed to the allergen on the
                  second occasion.   2 marks

_____

_____

_____

          ii.   Why would further exposure to the allergen lead to a more severe allergic response?   2 marks

_____

_____

_____

Question 6 (6 marks)

Cholera disease is caused by the bacterium *Vibrio cholerae*. The symptoms are very severe, and include watery diarrhoea caused by toxins which are released by the bacterium in the gut after consuming food prepared in faecally-contaminated water.

a. **i.** Describe the general structure of a bacterium. 1 mark

_____

_____

_____

ii. Describe a measure that could be taken to reduce the spread of cholera during an outbreak. 1 mark

_____

_____

_____

Dukoral is a cholera vaccine consisting of whole killed *Vibrio cholerae* cells.

b. **i.** Explain how a killed *Vibrio cholerae* cell is still able to be an effective vaccine. 2 marks

_____

_____

_____

ii. Describe the lymphatic systems role in an effective immune response against *Vibrio cholerae*. 2 marks

_____

_____

_____

_____

Question 7 (5 marks)

The following diagram represents six of the 46 chromosomes from a human karyotype. The sex chromosomes are labelled. A variety of genes and alleles are located on these chromosomes.
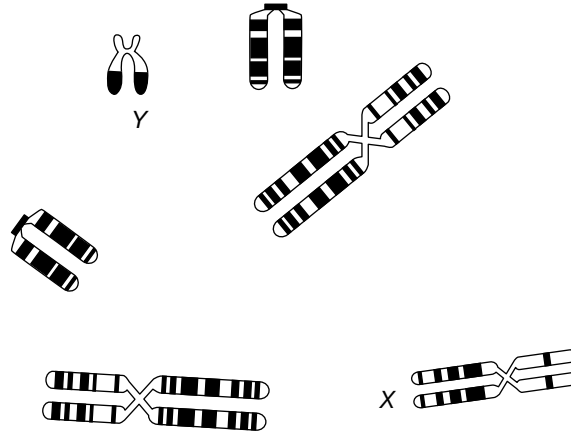
a. **i.** Label on the diagram the location of the alleles for an individual with a genotype of AaBb. 1 mark

    ii. Label on the diagram the location of the alleles for an individual with the genotype of ACac. 1 mark

    iii. How many possible gamete combinations are possible with respect to these six chromosomes? 1 mark

_____

b. In the space below, draw the chromosome arrangement expected in one of the possible gametes produced if the cell that these chromosomes are a part of was undergoing meiosis. 2 marks
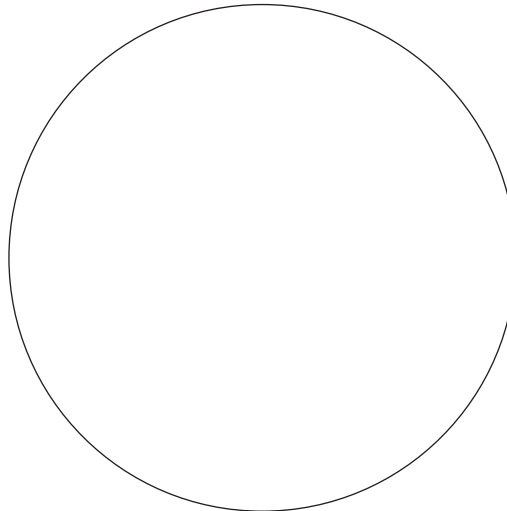
Question 8 (6 marks)

Cats possess a gene for producing a tail. Manx cats lack a tail and are sought after pets for cat enthusiasts. The following crosses were carried out between cats possessing tails and cats not possessing tails in an effort to determine the inheritance pattern of the tailless phenotype.

Cross number	Parental phenotypes	Phenotypic ratio of offspring
1	tailed * tailed	all tailed
2	tailless * tailless	2 tailless : 1 tailed
3	tailed * tailless	1 tailed : 1 tailless

a. Define the term phenotype. 1 mark

_____

_____

b. **i.** Which cross enables the conclusion to be made that the tailless phenotype is dominant? 1 mark

_____

ii. Explain your answer to part **b. i.** 2 marks

_____

_____

_____

c. Explain why the result for cross 2 is unexpected. 2 marks
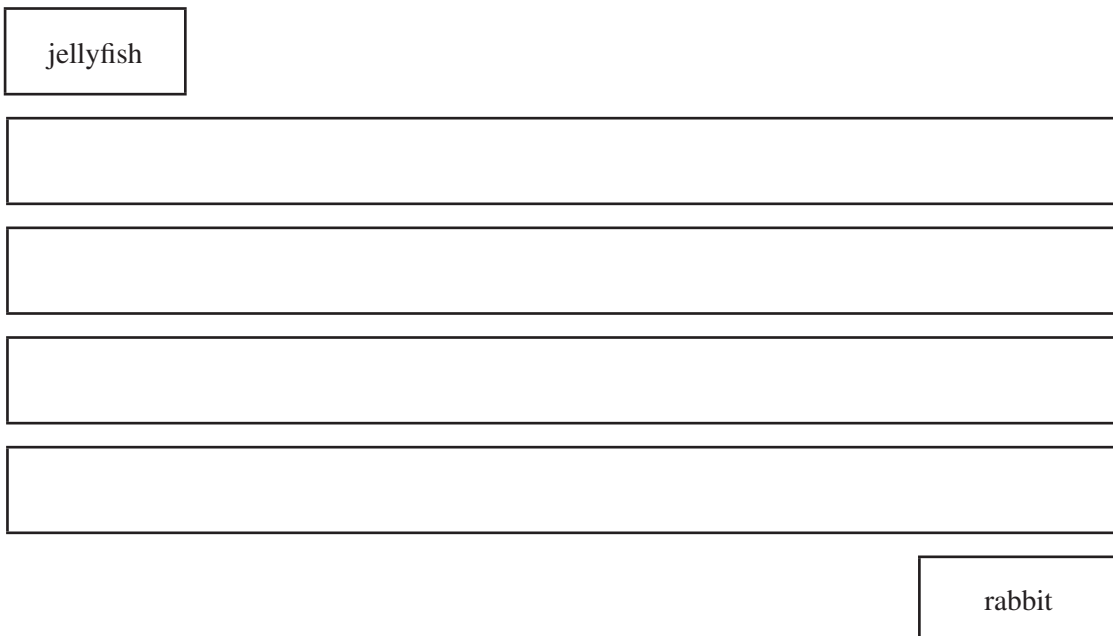
_____

_____

_____

Question 9 (6 marks)

The gene that codes for a green fluorescing protein (GFP) that is found naturally in jellyfish has been successfully transferred from the jellyfish genome into the genomes of other species such as rabbits and fish. In the future, this technology could possibly be used to monitor gene transfer in humans for the treatment of cancer.

a. What property does DNA have that enables it to be transferred from one species to another?   1 mark

_____

_____

To transfer genes from one organism to another, a variety of techniques can be used. These include the use of **restriction enzymes**, **PCR**, **vectors** and **ligase enzymes**.

b. Construct a flow chart that illustrates the sequence of steps that could be taken to successfully transfer a gene from one organism to another. Do this by placing the techniques listed above in the correct order, and briefly describe the importance of that step.   3 marks

```
┌─────────────┐
│  jellyfish  │
└─────────────┘

┌─────────────────────────────────────────────────────────────────────┐
│                                                                       │
└─────────────────────────────────────────────────────────────────────┘

┌─────────────────────────────────────────────────────────────────────┐
│                                                                       │
└─────────────────────────────────────────────────────────────────────┘

┌─────────────────────────────────────────────────────────────────────┐
│                                                                       │
└─────────────────────────────────────────────────────────────────────┘

┌─────────────────────────────────────────────────────────────────────┐
│                                                                       │
└─────────────────────────────────────────────────────────────────────┘

                                                    ┌─────────────┐
                                                    │   rabbit    │
                                                    └─────────────┘
```

Plasmids with antibiotic-resistant genes are often used to transfer genes of interest. However, the success rate of the transfer process is not 100%.

c. Discuss how a plasmid with an antibiotic-resistant gene is used to make it easier to select the plasmids that have been successfully modified.   2 marks

_____

_____

_____

_____

Question 10 (5 marks)

Bacterial resistance to antibiotics is a major issue in modern society mainly as a result of the over-prescription of antibiotics that kill bacteria which cause an infection. In a ten-year study conducted in the United Kingdom it was shown that there was a 40% increase in the number of patients presenting with a bacterial infection.

a. How could this data be used to conclude the bacteria are becoming resistant to antibiotics? 1 mark

_____

_____

_____

b. Explain how the use of antibiotics to treat bacterial infections is an example of natural selection. 3 marks

_____

_____

_____

_____

c. Explain how the use of antibiotics is an example of cultural evolution. 1 mark

_____

_____

_____

Question 11 (4 marks)

After a landslide in an area renowned for fossils, a large number of stratigraphic layers were revealed. Following a complete excavation, the layout of the strata was illustrated as a diagram, shown below. There were two layers that contained fossils (*A* and *B*) and seven layers that contained volcanic rock.
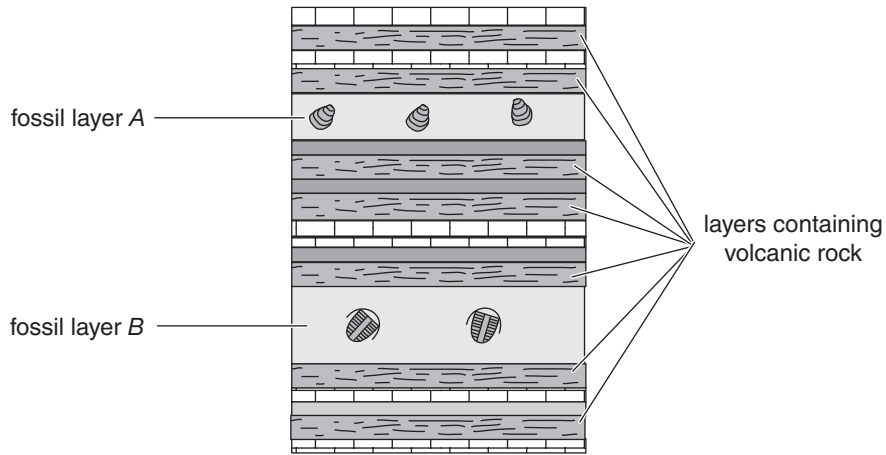
a. What conclusion can be made about the age of fossil layer *A* compared to fossil layer *B*? 1 mark

_____

To get an absolute date of the fossils in layer *A* or layer *B*, radioisotopic dating methods (such as potassium/argon) can be used. Using one such method, the volcanic rock above and below fossil layer *B* was aged to be 520 and 545 million years old, respectively.

b. **i.** Describe how the potassium/argon method could be used to date volcanic rock such as these two layers. 2 marks

_____

_____

_____

_____

ii. What can be concluded about the age of the fossils in layer *B*? 1 mark

_____

Question 12 (6 marks)

There are many different methods that can be used to determine our *Homo sapien* origins. An example is to compare DNA mutations that have accumulated in different human groups. One study was to investigate the mutations in mitochondrial DNA (mtDNA) and compare them, rather than looking at mutation rates in the nuclear DNA.

a.   **i.**   What would be the advantage of investigating mutation rates in mtDNA rather than nuclear DNA?   2 marks

_____

_____

_____

      ii.   How can mutation rates be used to determine how long ago we diverged from our ancestors?   1 mark

_____

_____

The mtDNA carries several regions, and one that was investigated was the non-coding hypervariable region 1 (HVR1) of the mtDNA.

b.   What would be the advantage of investigating the HVR1 region of the mtDNA?   1 mark

_____

_____

_____

The results of these tests indicated that *Homo sapiens* originated in Africa about 150 000 years ago. They appeared in different regions around the world at the times indicated in the table below.

Region	Time of emergence (years ago)	Other information
Africa	150 000	
Middle East	100 000	This group branched to Europe and Asia.
Europe	40 000	
Asia	20 000	

c.   How could the HVR1 mutations from each region be compared to each other so that different times of emergence could be determined?   2 marks

_____

_____

_____

END OF QUESTION AND ANSWER BOOKLET