



Trial Examination 2013

VCE Biology Units 3 & 4

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 2 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Number of marks
A	40	40	40
B	10	10	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 31 pages.
Answer sheet for multiple-choice questions.

Instructions

Write your **name** and **teacher's name** on this book 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 book.

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

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2013 VCE Biology Units 3 & 4 Written Examination.

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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.

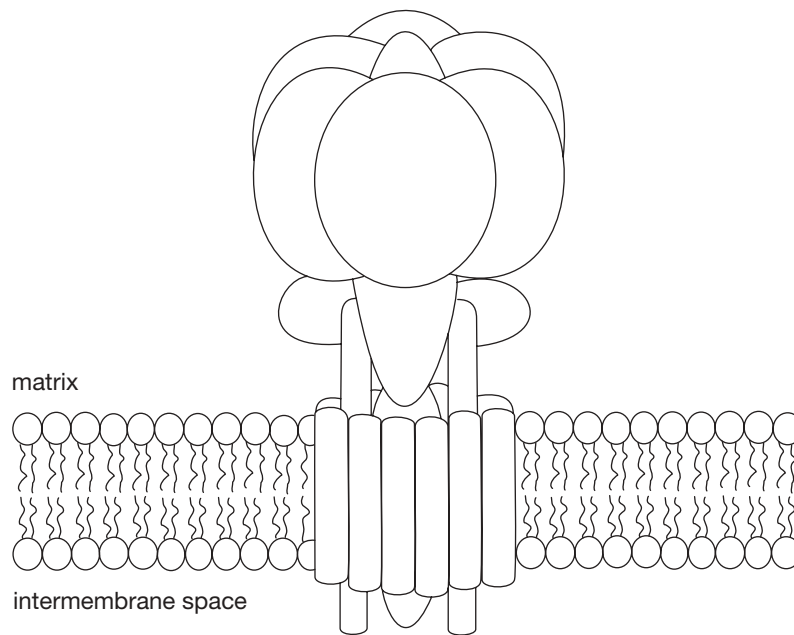
Question 1

Ribose is a type of

- A. amino acid.
- B. fatty acid.
- C. carbohydrate.
- D. nucleotide.

Use the following information to answer Questions 2 and 3.

The biomacromolecule pictured below spans the inner mitochondrial membrane and plays an important role in ATP synthesis within eukaryotic cells.



Question 2

The highest level of the structure illustrated in the diagram of the biomacromolecule is

- A. primary.
- B. secondary.
- C. tertiary.
- D. quaternary.

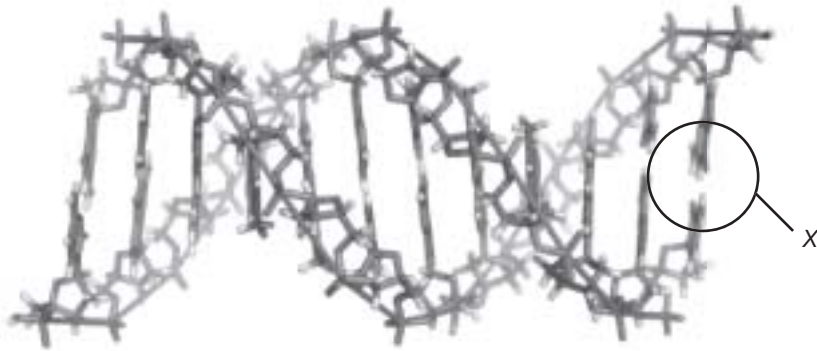
Question 3

The type of reaction that forms ATP is

- A. exergonic.
- B. catabolic.
- C. anabolic.
- D. hydrolysis.

Use the following information to answer Questions 4 and 5.

The diagram below is of a biomacromolecule that is found in most cells.

**Question 4**

The section of the molecule labelled X is illustrating

- A. complementary base pairing.
- B. a nucleotide.
- C. deoxyribose.
- D. a triplet.

Question 5

In eukaryotic cells, this biomacromolecule would be located in the

- A. nucleus only.
- B. nucleus and mitochondria only.
- C. nucleus and chloroplast only.
- D. nucleus, chloroplast and mitochondria.

Question 6






With respect to protein synthesis,

- A. replication of the DNA template occurs in the nucleus.
- B. transcription of the mRNA occurs at the ribosome.
- C. amino acids are joined during translation.
- D. exons are removed from the pre-mRNA.

Use the following information to answer Questions 7 and 8.

An experiment was conducted that investigated the effect of temperature on the function of amylase. Amylase catalyses the breakdown of starch and this can be measured by using an iodine solution. Iodine is a chemical that stains dark in the presence of starch. The procedure is summarised in point form below.

- Five Petri dishes were prepared with a 2% starch and gelatin (solid at temperatures below 60°C) solution.
- A small hole was made in the middle of the Petri dish in which a solution of amylase was added.
- The resulting Petri dishes were exposed to a variety of temperatures (10°C, 20°C, 30°C, 40°C, 50°C).
- After a 24-hour incubation period, the Petri dishes were washed in a weak solution of iodine to test for the presence of starch. The results are illustrated below.

10°C	20°C	30°C	40°C	50°C
				

Question 7

The independent variable in this experiment would be the

- diameter of the circle where there is no evidence of starch.
- temperature.
- area within the Petri dish where starch is present.
- size of the Petri dishes.

Question 8

With respect to the experimental results, an appropriate explanation could be:

- at 50°C amylase is denatured.
- at 10°C the number of collisions between amylase and starch is zero.
- at 40°C the production of starch is at a maximum.
- at 20°C and 30°C the amylase is partially denatured.

Question 9

In non-competitive inhibition of an enzyme, the inhibitor

- attaches to the active site, preventing the substrate from attaching there.
- attaches to the substrate, preventing it from attaching to the active site.
- causes the substrate molecules to polymerise, preventing individual enzyme-substrate attachment.
- attaches to the enzyme at a site away from the active site, altering the shape of the enzyme.

Question 10

With respect to photosynthesis, the most correct statement is

- the Calvin cycle occurs within the grana.
- ATP-ase allows hydrogen ions to move from the stoma into the grana.
- a water-splitting enzyme is activated by the action of light energy in chlorophyll.
- glucose is produced in the stroma as part of the light-dependent reaction.

Question 11

Feedback mechanisms can regulate the rate of enzyme activity, effectively turning off an enzyme in a reversible way until more product is needed.

The statement that best describes the regulation of enzyme action as a feedback mechanism is

- A. reduced concentration of product causes the active site to change shape so the substrate no longer fits.
- B. increasing the concentration of the substrate leads to lowered enzyme activity.
- C. a change in pH specifically alters the active site of an enzyme within the cytosol.
- D. temporary binding of a non-substrate molecule to the active site competes with the actual substrate, thus slowing the accumulation of the product.

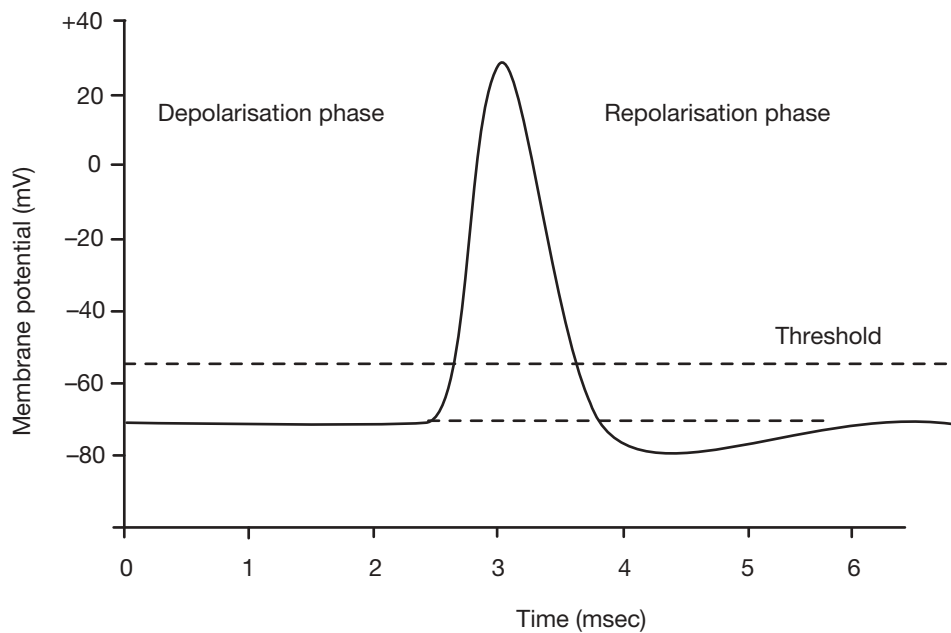
Question 12

Pheromones

- A. are a type of signalling molecule.
- B. are a hormone.
- C. generally bind to receptors within the organism that secreted them.
- D. are an important type of neurotransmitter.

Question 13

The following graph represents an action potential.



Depolarisation along an axon is started by

- A. sodium channels opening, which allows sodium ions to move from the cytosol to outside the cell.
- B. potassium channels opening, which allows potassium ions to move from the cytosol to outside the cell.
- C. sodium channels opening, which allows sodium ions to move from outside the cell into the cytosol of the cell.
- D. potassium channels opening, which allows potassium ions to move from outside the cell into the cytosol of the cell.

Question 14

Once the nerve message reaches the synapse the message can then be passed onto the next nerve.

The most accurate explanation of this synaptic transmission is

- A. calcium channels open and the influx of calcium promotes endocytosis of neurotransmitters into the synaptic gap, which then bind to receptors on the post synaptic side of the synapse.
- B. vesicles containing neurotransmitters are released from the post synaptic side of the synapse by exocytosis, which then bind to receptors on the dendrite.
- C. calcium channels open at the end of the axon, triggering the release of neurotransmitters into the synaptic cleft, which then bind to receptors on the post synaptic membrane.
- D. vesicles containing neurotransmitters move into the synapse and bind to receptors on the pre synaptic side of the synapse.

Question 15

Consider the action of a peptide hormone.

Arrange the following events in the correct sequence:

1. The activating hormone interacts with a membrane-bound receptor.
2. Cyclic AMP causes the cell to carry out a function characteristic for that specific hormone.
3. Adenylyl cyclase catalyses the transformation of ATP to cyclic AMP.
4. Adenylyl cyclase is activated.

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

Question 16

An unknown disease causes severe symptoms in one particular human. An epidemiologist took a sample of diseased tissue from the patient and analysed it so as to determine the cause. The table below shows the results of the analysis.

Test	Test Type	Findings
1	microscopic analysis	no pathogenic cells were found in the sample
2	denaturing any nucleic acid in the sample	the sample was still infective
3	denaturing any nucleic acid and protein in the sample	the sample was no longer infective
4	denaturing the proteins only within the sample	the sample was no longer infective

Based on the results of the tests, the disease could be caused by a

- A. prion.
- B. virus.
- C. bacteria.
- D. protozoan.

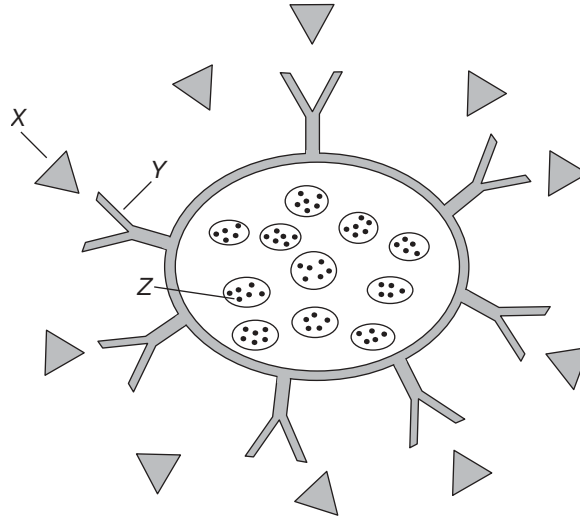
Question 17

Of the following selections, the one that includes only non-specific defences is:

- A. hair, skin, complement, inflammation, phagocytosis
- B. hair, skin, mucous membranes, antibodies
- C. antigens, antibodies, complement, macrophages
- D. T and B cell activation, complement, inflammation, phagocytosis

Question 18

The diagram below shows a mast cell coming in contact with an allergen.



The structures labelled X, Y and Z respectively are called

- A. allergen, antibody and histamine.
- B. allergen, histamine and antibody.
- C. antibody, allergen and histamine.
- D. antibody, histamine and allergen.

Question 19

When a B cell encounters antigens to which it is targeted, it divides rapidly and produces

- A. interferons.
- B. mast cells.
- C. killer cells.
- D. plasma cells.

Question 20

Vaccination is effective because it

- A. permanently raises the number of white blood cells in the body.
- B. creates memory cells that have the potential to quickly produce specific antibodies.
- C. causes the disease, which you will only get once in your life.
- D. consists of antibodies that stay in the body permanently and destroy viruses.

Question 21

The first milk a newborn drinks through breastfeeding is called colostrum. Apart from containing a variety of nutrients needed for nourishment, colostrum also has a variety of antibodies in it that reduces the chance of the baby suffering pathogenic diseases early in its life.

This is a form of

- A. passive natural immunity.
- B. active natural immunity.
- C. passive artificial immunity.
- D. active artificial immunity.

Use the following table to answer Questions 22 and 23.

Animal name	Diploid number
gorilla	48
mouse	40
mosquito	6

Question 22

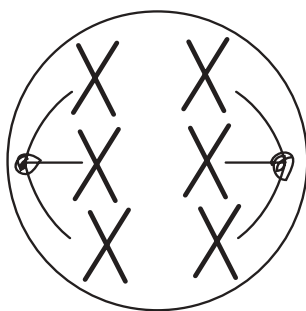
The number of sex chromosomes in the gametes of these animals would be

- A. 24 (gorilla), 20 (mouse), 3 (mosquito).
- B. 48 (gorilla), 40 (mouse), 6 (mosquito).
- C. two in each gamete regardless of the animal.
- D. one in each gamete regardless of the animal.

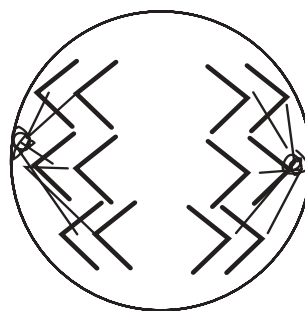
Question 23

An illustration of a cell from the gonad of a female mosquito in a second meiotic division is represented by

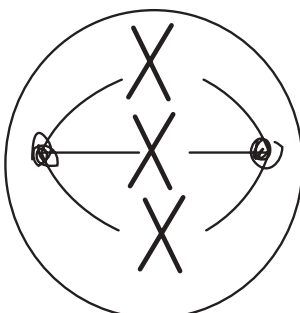
A.



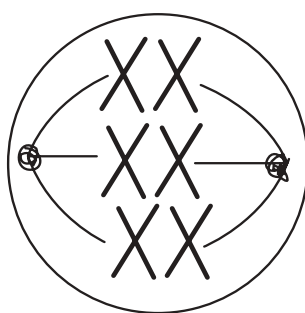
B.



C.

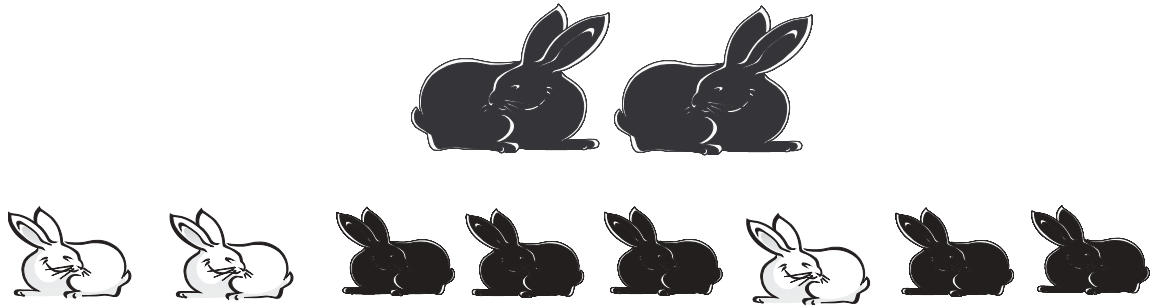


D.



Question 24

Coat colour in rabbits is a genetically inherited trait. Two black rabbits produced a litter of offspring as illustrated in the diagram below.



Based on this information alone it is possible to conclude that

- A. the parent rabbits are heterozygous.
- B. the white offspring are heterozygous.
- C. if two more rabbits had been born in this litter, they would have been black.
- D. the inheritance of coat colour is sex-linked.

Question 25

One gene is involved with ABO blood typing; however, there are four possible phenotypes.

The best explanation for this is that there are

- A. two alleles displaying incomplete dominance.
- B. three alleles with a hierarchical dominance of $A > B > O$.
- C. three alleles with a relationship of $A = B$ but they are both dominant over O .
- D. four alleles and each genotype displays a different phenotype.

Question 26

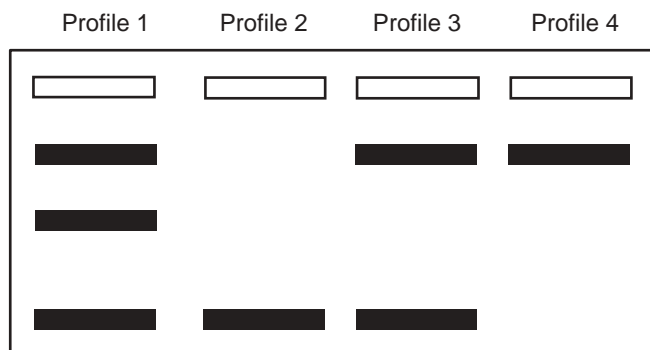
Pea plants *Pisum sativum* can have white (v) or violet (V) flowers or they can be short (t) or tall (T).

If these two genes are independently inherited, what would be the phenotypic ratio of a cross between pea plants with the genotypes VVtt and VvTt?

- A. 25% VVTt, 25% VVtt, 25% VvTt, 25% Vvtt
- B. 50% tall plants with violet-coloured flowers and 50% short plants with violet-coloured flowers
- C. 50% VVtt, 50% VvTt
- D. nine tall violet, three tall white, three short violet and one short white

Question 27

Gel electrophoresis can be used to diagnose genetic diseases such as cystic fibrosis, an autosomal recessive disorder. The faulty CFTR allele is shorter than the normal CFTR allele and the differences can be seen as a genetic profile. An unborn child, whose parents were both heterozygous, was tested for cystic fibrosis. The profiles below show some of the results that could be expected with a genetic test such as this one.

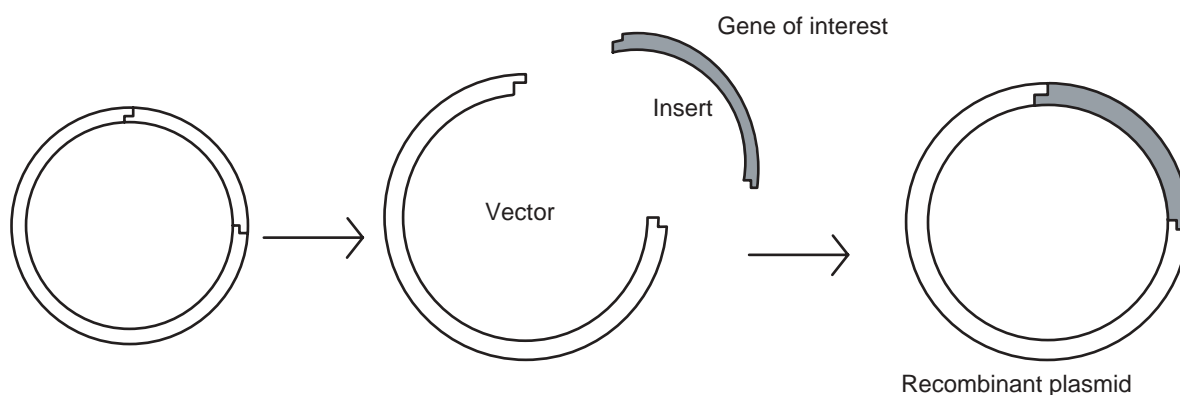


The profile that is consistent with a heterozygous child is

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

Question 28

The following diagram illustrates the steps involved in producing a recombinant plasmid.



Various chemicals need to be mixed at certain stages in the transformation process.

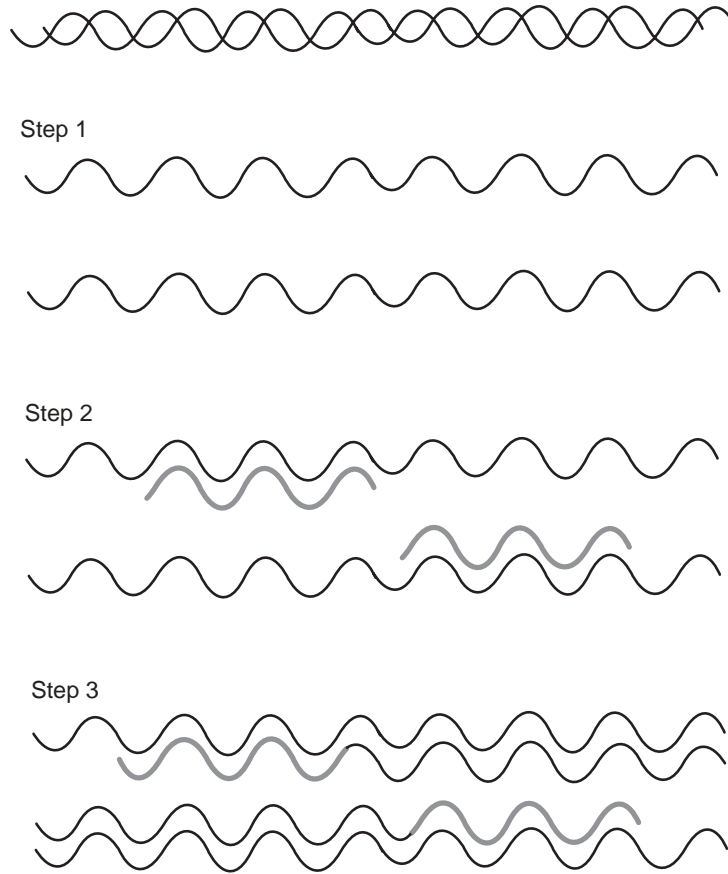
The correct order of chemical use would be:

	Step 1	Step 2
A.	restriction enzymes are added to the plasmid	the cut plasmid, gene of interest and ligase are added together
B.	ligase is added to some of the restriction enzymes	both are then mixed with the plasmid and the gene of interest
C.	mix the plasmid and the gene of interest with ligase	followed by restriction enzymes soon after
D.	the gene of interest and the original plasmid are added	the restriction enzyme and ligase are added

Use the following information to answer Questions 29 and 30.

PCR has been used to amplify specific sections of DNA from small samples. It has uses in DNA sequencing, forensic analysis and genetic testing for diseases.

The diagram below illustrates the steps involved in each replication cycle.



Question 29

A temperature of 50°C is needed for

- A. step 1 only.
- B. step 2 only.
- C. step 3 only.
- D. step 2 and 3 only.

Question 30

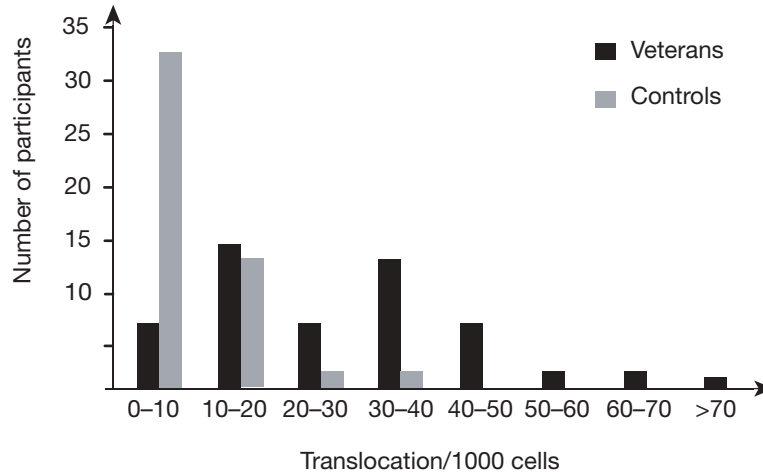
At the beginning of the first PCR cycle there was one DNA strand.

After 5 cycles there would be

- A. 5 strands.
- B. 16 strands.
- C. 32 strands.
- D. 64 strands.

Question 31

In 1957–58 the British Government conducted a series of nuclear tests in the mid-Pacific (code-named Operation Grapple). This involved 551 personnel onboard naval vessels that were stationed at various distances between 20 and 150 nautical miles from ground zero. Recently, a biotechnological technique called mFISH was carried out with many of the surviving personnel to investigate a potential link between chromosomal translocations and nuclear radiation exposure. The results are shown in the graph below.



Based on the results of these tests, it can be said that

- A. the nuclear radiation caused the translocations.
- B. there are more 10–20 or greater translocations per 1000 cells in the veterans compared to the control group.
- C. the control group would have been the same age as the 551 personnel were in 1957–58.
- D. there were over 200 participants involved in the testing.

Question 32

Allele frequencies in gene pools of populations usually remain relatively stable over long time periods if

- A. populations are very large.
- B. a single advantageous mutation became more common within the gene pool.
- C. the environmental conditions are changing.
- D. there is no selective advantage for any particular phenotype.

Question 33

A pregnant Florida panther (an endangered species, *Puma concolor*) was hit by a truck while crossing a rural highway in the USA. The panther and the three cubs she was carrying were killed. As a result of this accident, a dominant allele for resistance to a deadly feline influenza virus is, by chance, lost from the population.

This would be an example of

- A. gene flow.
- B. natural selection.
- C. genetic drift.
- D. genetic bottleneck.

Question 34

The domestic cat (*Felis catus*) is a small and carnivorous mammal. Cats are valued by humans for companionship as well as their ability to hunt pests. They differ markedly from their ancestors and can vary in size (from as little as 0.6 kg up to 21 kg) and body hair (some have no hair and some have hair as long as 10 cm).

The development of domestic cats is the result of

- A. natural selection.
- B. the founder effect.
- C. structural homologies.
- D. artificial selection.

Question 35

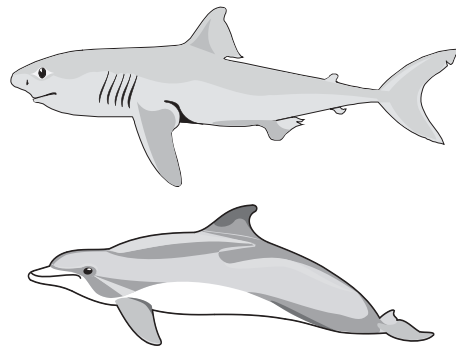
Bacterial resistance to antibiotics is increasing as a result of the over prescription of antibiotics. Diseases such as *Staphylococcus aureus* (MRSA or golden staph) and multi-drug-resistant *Mycobacterium tuberculosis* (MDR-TB) are serious public health problems.

It would be reasonable to say that

- A. the overuse of antibiotics caused the mutations that led to antibiotic resistance.
- B. some strains of MRSA and MDR-TB were originally resistant to antibiotics.
- C. a new antibiotic would eradicate all the remaining antibiotic resistant bacteria.
- D. in a human that had been prescribed antibiotics, the non-resistant bacteria were at a selective advantage in that environment.

Question 36

The shark and dolphin have a similar phenotype as illustrated in the diagram below.



The dolphin belongs to the order artiodactyl and evolved 50 million years ago. The shark belongs to the order megamouth and evolved 400 million years ago.

These two organisms have a similar phenotype due to

- A. divergent evolution.
- B. convergent evolution.
- C. allopatric speciation.
- D. adaptive radiation.

Question 37

In the human population, mitochondrial mutation rate is hypothesised to be one change every 1000 years. As such, these differences have been used as a biological clock to determine how long ago particular individuals may have had a common ancestor.

The table below shows the mitochondrial DNA differences between two individuals (assume the rest of their mtDNA is identical).

Mitochondrial sequence	1	2	3	4	5	6	7	8	9	10	11	12
Individual 1	T	T	A	G	C	A	A	T	G	C	T	A
Individual 2	T	A	A	G	C	T	A	T	C	G	T	A

According to this information, Individual 1 and 2 had a common ancestor

- A. 1000 years ago.
- B. 2000 years ago.
- C. 3000 years ago.
- D. 4000 years ago.

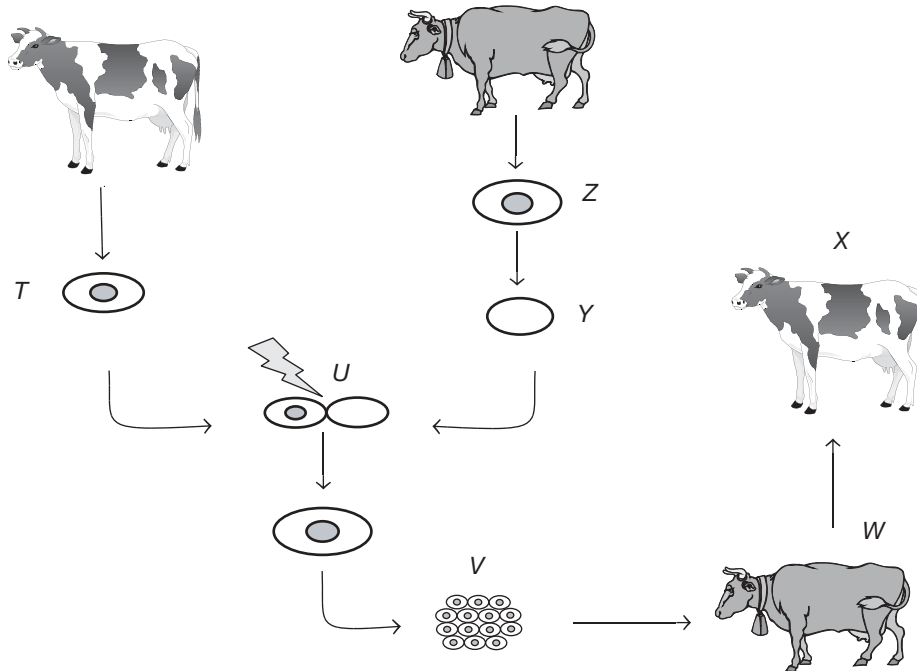
Question 38

The main structural feature that was different between the genus *Australopithecus* and the genus *Homo* is that

- A. *Australopithecus* had a smaller cranial capacity than *Homo*.
- B. *Australopithecus* was generally taller than *Homo*.
- C. *Australopithecus* did not have opposable thumbs, whereas *Homo* did.
- D. *Australopithecus* had a more central foramen magnum compared to *Homo*.

Use the following information to answer Questions 39 and 40.

An agricultural geneticist is interested in developing a herd of cloned cows to maximise their milk production. He used the steps or technique outlined below (*T* to *Z*) to develop the herd.



Question 39

The correct description of the steps or techniques is:

- A. *T*: donor cell, *U*: fusion, *V*: embryo, *W*: surrogate, *X*: clone, *Y*: enucleated ova, *Z*: ova
- B. *T*: surrogate, *U*: fusion, *V*: embryo, *W*: clone, *X*: donor, *Y*: enucleated ova, *Z*: ova
- C. *T*: donor cell, *U*: fusion, *V*: embryo, *W*: clone, *X*: surrogate, *X*: ova, *Y*: enucleated ova
- D. *T*: ova, *U*: fusion, *V*: embryo, *W*: surrogate, *X*: clone, *Y*: enucleated donor cell, *Z*: donor cell

Question 40

It would be reasonable to say that the cloned herd would

- A. have the same phenotype.
- B. have the same genomes.
- C. be better equipped to survive an outbreak of foot and mouth disease.
- D. all look identical.

SECTION B: SHORT-ANSWER QUESTIONS

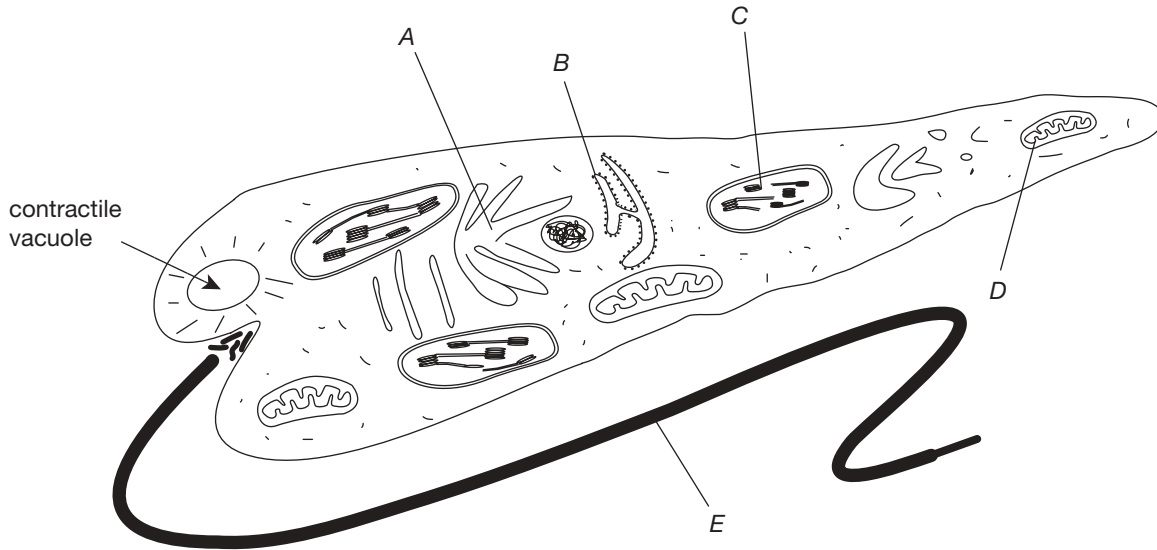
Instructions for Section B

Answer this section in **pen**.

Answer all questions in the spaces provided.

Question 1 (6 marks)

Euglena is a member of the kingdom Protista and they are very interesting to study as they have features of plants as well as animals. The diagram below is of a freshwater *euglena* as seen using an electron microscope. Structures A to E are cellular structures and a contractile vacuole is clearly labelled.

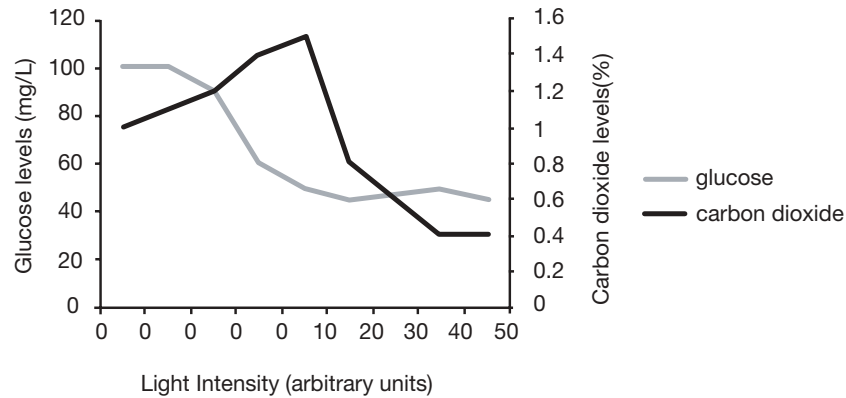


- a. i. Describe the survival advantage of the contractile vacuole to the *euglena*. 1 mark

- ii. Select two of the structures (A to E) that would assist the survival of the *euglena* in an environment suited to an animal-like existence. 2 marks

Structure (A to E)	Name of the Structure	How the structure suits an animal-like existence

A series of experiments were conducted on populations of *euglena* in an enclosed environment. Factors such as CO₂ and glucose were measured in the solution the *euglena* was immersed in while they were exposed to variations in light intensity. The first five measurements were conducted in the dark and then the light was increased. The results of the experiments are shown in the graph below.



- b. i.** What was the highest carbon dioxide percentage measured in the solution the *euglena* were immersed in? 1 mark

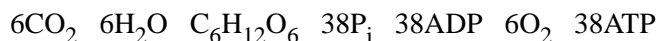
- ii.** Use evidence from the graph to illustrate that *euglena* can have animal-like metabolism when the light intensity is zero. 1 mark

- iii.** Explain the relationship between light intensity and carbon dioxide levels. 1 mark

Question 2 (6 marks)

Cellular respiration is a very important process that provides energy for metabolism. There are many steps involved in the breakdown of glucose aerobically.

- a. Rearrange the chemicals below to construct a balanced chemical equation for aerobic respiration. 2 marks



One enzyme that is part of this metabolic process is called pyruvate kinase. It catalyses the conversion of phosphoenolpyruvate into pyruvate.

- b. How is the structure of pyruvate kinase related to its function as a biomacromolecule? 2 marks

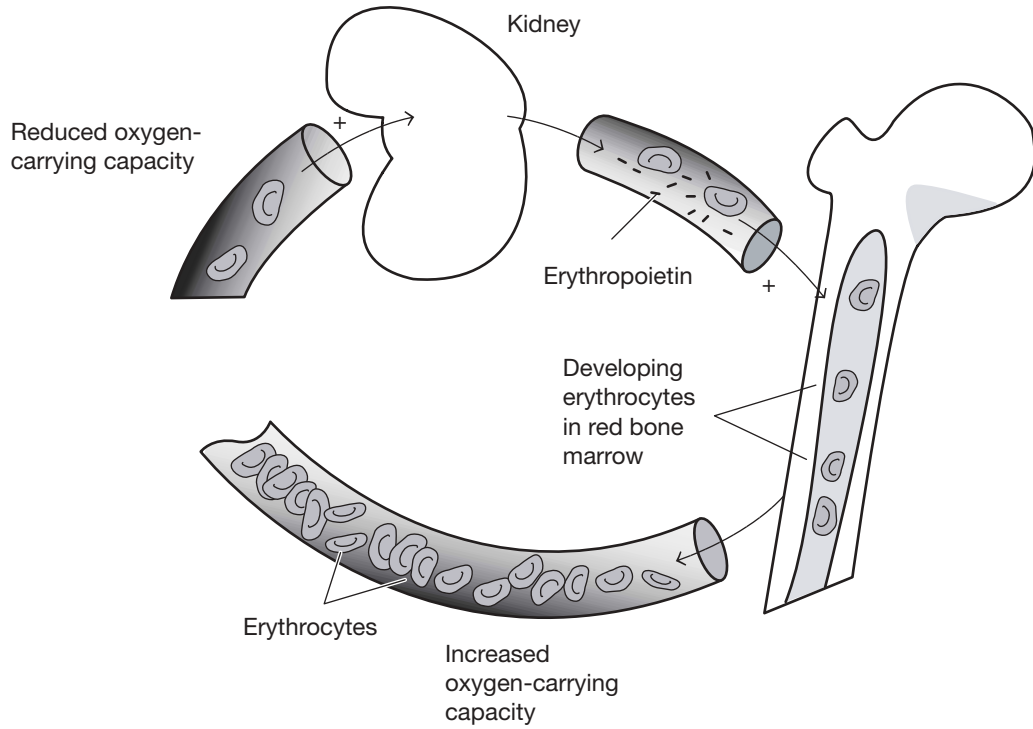
- c. Pyruvate is occasionally referred to as a molecule at the 'crossroads' of metabolism. Discuss this statement with respect to cellular respiration. 2 marks

Question 3 (9 marks)

Erythropoietin (often shortened to EPO) is a protein hormone, secreted by the kidneys, whose function is to regulate red blood cell production. EPO stimulates bone marrow to produce more red blood cells (RBC). For this reason EPO is most commonly used amongst endurance athletes as a higher RBC count means better oxygen transportation and so a higher rate of aerobic respiration. The faster the rate of aerobic respiration, the higher the level at which the athlete can work without utilising the anaerobic systems which produce lactic acid and cause fatigue.

- a. Discuss the differences in the energy efficiency of aerobic respiration and anaerobic respiration. 1 mark

The diagram below shows the interaction between EPO and blood cells. The '+' represents stimulation.



- b. i.** Explain why the regulation of the number of red blood cells is an example of negative feedback. 2 marks

- ii.** Name the effector from the diagram above. 1 mark

Testosterone is a lipid-based hormone that has occasionally been used in conjunction with EPO by elite athletes trying to gain an illegal advantage. In an effort to understand the effect these two hormones have on skeletal muscle function, scientists can use cell lines. A skeletal muscle cell line is a dish of muscle cells that, given the right conditions, can live for a long time.

- c.** Design an experiment using a skeletal muscle cell line to investigate the hypothesis that ‘raising levels of testosterone will lead to an increase in skeletal muscle mass.’ In your answer show an understanding of controls, variables and controlled conditions. You may use a diagram to help answer the question. 3 marks

- d.** Discuss the differences in the action of testosterone and EPO at their target tissue. 2 marks

Question 4 (7 marks)

The effect of changing Gibberellic Acid (GA) on the germination of *Penstemon digitalis* seeds (a commercially available flowering plant) was investigated. In an experiment, 100 seeds were soaked in various solutions of GA as illustrated in the table below.

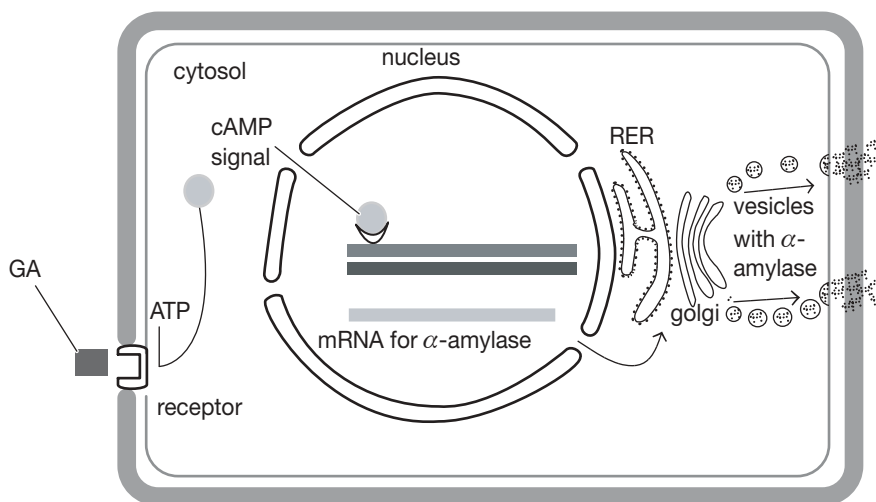
Gibberellic Acid (mg/L)	Germination percentage after fifteen days
0	10
10	20
50	23
100	25
200	35
500	55
1000	85

- a. i. State two conditions that would need to have been kept constant for the duration of the experiment. 1 mark

- ii. What is the relationship between the concentration of GA and the germination? 1 mark

- b. Name a plant hormone other than GA and discuss its importance in plant survival. 2 marks

A model for the activation of a starch digesting enzyme (α -amylase) in seed cells of *Penstemon digitalis* is summarised in the diagram below.



c. i. How does the presence of GA lead to the secretion of α -amylase from the seed cell? 2 marks

ii. Explain how the presence of GA leading to the secretion of α -amylase from the seed cell is an example of signal amplification. 1 mark

Question 5 (7 marks)

Worldwide, cervical cancer is the fourth most deadly cancer in women and has a mortality rate of about fifty percent. The main cause of cervical cancer is the Human Papilloma Virus (HPV) and due to a thorough vaccination program, the number of women developing cervical cancer has significantly dropped over the past decade.

- a. Describe the general structure of a virus such as HPV. 1 mark

There are more than 120 different types of HPV (they are classified with a number of one to 120) and about 30 of these viruses can be passed from one person to another through sexual contact. Some of the HPVs pathogenic to humans can lead to cervical cancer. However, it should be noted that HPV is not the only cause of cervical cancer and HPV can cause other cancer types as illustrated in the table below.

Cancer area	Average annual number of cases	HPV Attributable (estimated)	HPV 6, 11, 16 and 18 Attributable (estimated)
Cervix	12 000	11 500	9 000
Vaginal	700	500	400
Penis	1 000	400	300
Mouth (woman)	2 500	1 500	1 400
Mouth (men)	9 500	6 000	5 500

- b. i. Use the data to explain why the vaccination program mainly focuses on women. 1 mark

- ii. Use the data to explain why the vaccine only protects against HPV types 6, 11, 16 and 18. 1 mark

Gardasil is the trademark name for one of the vaccines available to protect against HPV types 6, 11, 16 and 18.

- c. In terms of the human immune response against HPV, describe the contents of the Gardasil vaccine. 1 mark

- d.** With respect to HPV-16 only, describe the steps involved after vaccination that leads to long-term protection against this strain. 3 marks

Question 6 (7 marks)

Letters **A** to **E** show some of the events of mitosis:

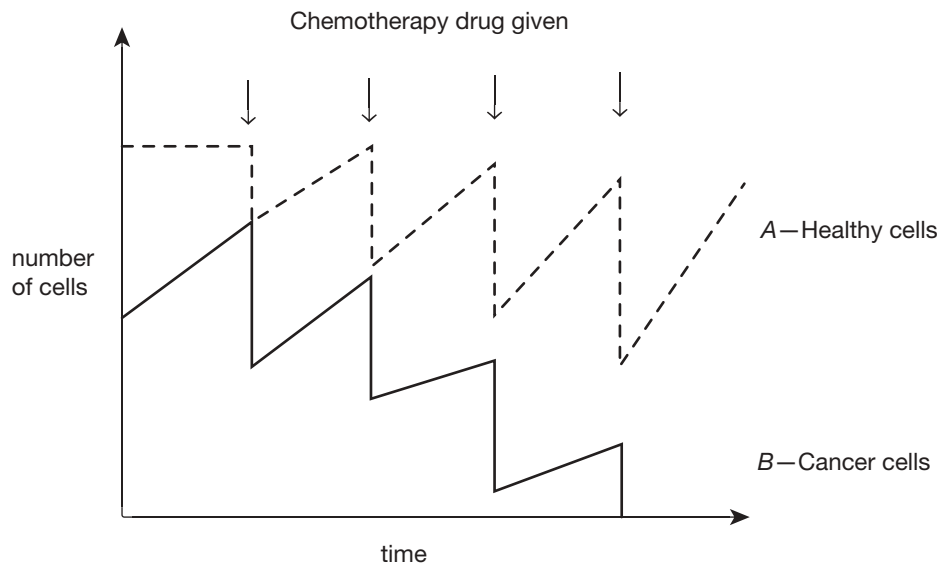
- A.** chromatids separate
- B.** nuclear envelope disappears
- C.** cytoplasm divides
- D.** chromosomes condense and become visible
- E.** chromosomes on the equator of the spindle

- a.** List these events in the correct order. 1 mark

- b.** Two students were arguing about mitosis and the cell cycle. One said they were independent events and the other said that mitosis was a part of the cell cycle.
Discuss which student is correct. 2 marks

- c.** If the DNA of the cell is damaged, a protein called p53 usually stops mitosis. Mutation in the gene for p53 could cause cancer to develop.
Explain how. 1 mark

Scientists produced a model to show how chemotherapy works in the treatment of cancer. The model is shown in the diagram below.



- d. i.** Compare the number of healthy cells to the number of cancer cells before the beginning of chemotherapy treatment. 1 mark

- ii.** Use the graph to illustrate that four successive treatments are required for the chemotherapy to be successful. 2 marks

Question 7 (5 marks)

The table below contains a list of amino acids and some of their corresponding codons

Amino acid/letter	Codons
Ala	GCU, GCC, GCG
Arg	CGU, CGA, AGA, AGG
Asn	AAU, AAC
Asp	GAU, GAC
Cys	UGU, UGC
Gln	CAA, CAG
Glu	GAA, GAG
Gly	GGU, GGC, GGA, GGG
His	CAU, CAC
Ile	AUU, AUC, AUA

Amino acid/letter	Codons
Leu	UUA, UUG, CUU
Lys	AAA, AAG
Met	AUG
Phe	UUU, UUC
Pro	CCU, CCC, CCA
Ser	UCG, AGU, AGC
Thr	ACU, ACC, ACA
Trp	UGG
Tyr	UAU, UAC
Val	GUU, GUA, GUG

- a. Discuss how many codons exist in nature.

2 marks

- b. A protein has an amino acid sequence of: Asn-Gly-Phe-Trp-Val.

Propose a possible DNA sequence that could code for this polypeptide.

3 marks

Question 8 (5 marks)

Albinism is inherited as an autosomal recessive trait. The genotype for a person suffering albinism would be **aa** and the genotype for a person not suffering albinism would be **Aa** or **AA**.

Red-green colour blindness is controlled by a sex-linked gene, found on the X chromosome. The dominant allele **X^C** leads to normal colour vision and the recessive allele **X^c** leads to colour blindness.

- a. i.** Give the genotype of a man with albinism who has normal colour vision. 1 mark

- ii.** Explain whether the genes for colour blindness and albinism are linked or independently inherited. 1 mark

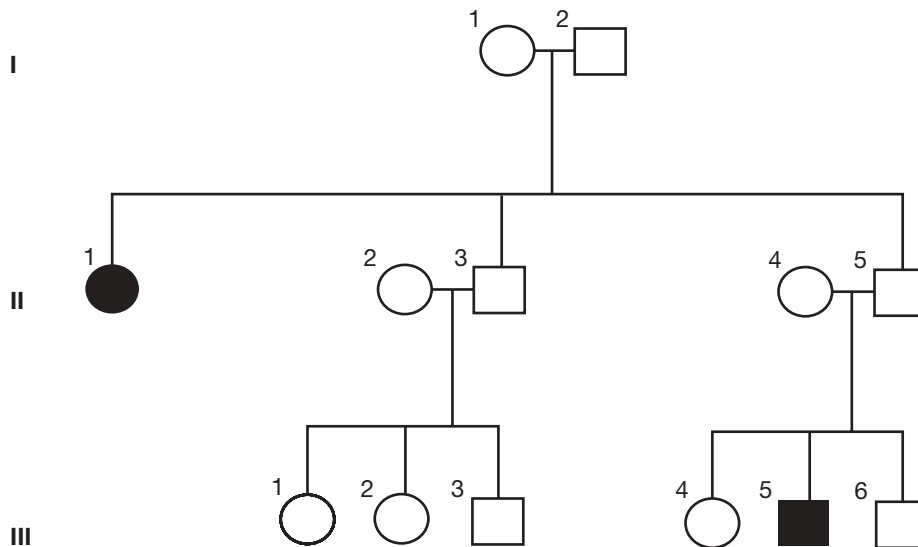
- b.** A mother and a father are both heterozygous for albinism. The father has normal colour vision and the mother is heterozygous for the gene for colour blindness.

Calculate the probability of a son of this couple being colour blind as well as having albinism.

Show your working. 3 marks

Question 9 (9 marks)

Sickle cell anaemia is a genetically inherited single gene blood disease where people with the disorder have hemoglobin molecules that can distort red blood cells into a sickle, or crescent shape. It is one of the most common genetic disorders on the African continent. A pedigree is illustrated showing the inheritance of the sickle cell trait (shaded individuals) in one particular African family. The mortality of sufferers with sickle cell anaemia is high.

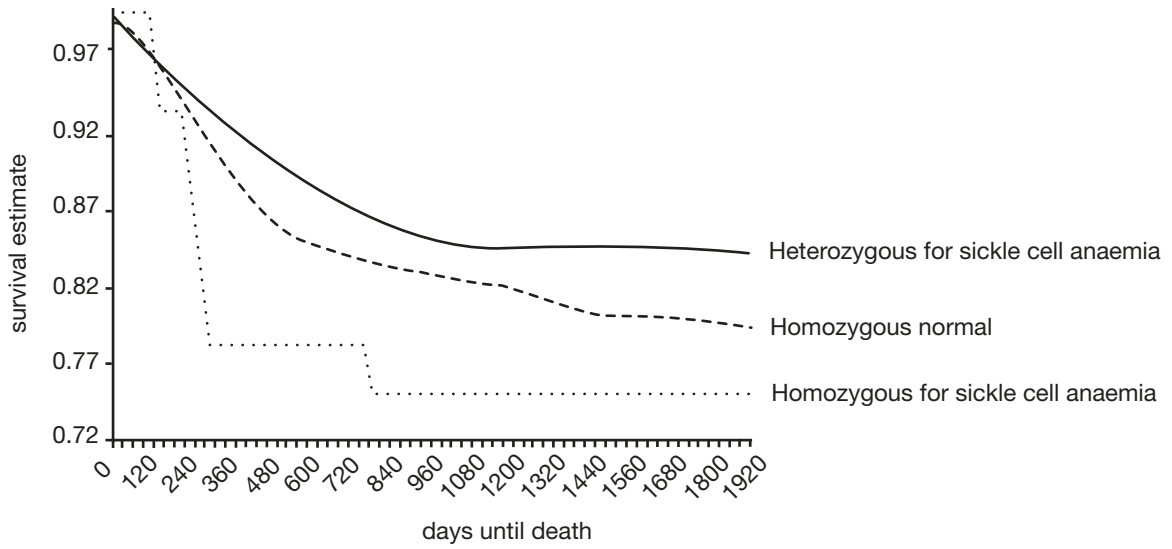


- a. i. Use evidence from the pedigree to predict the pattern of inheritance for sickle cell anaemia. 2 marks

- ii. Discuss the probability that any of the children of II-2 and II-3 would possess at least one faulty sickle cell allele. 2 marks

A study was conducted with a large group of East African children to investigate the impact of their genotype with respect to sickle cell anaemia and the number of days they are able to survive.

A graph illustrating these findings is shown below.



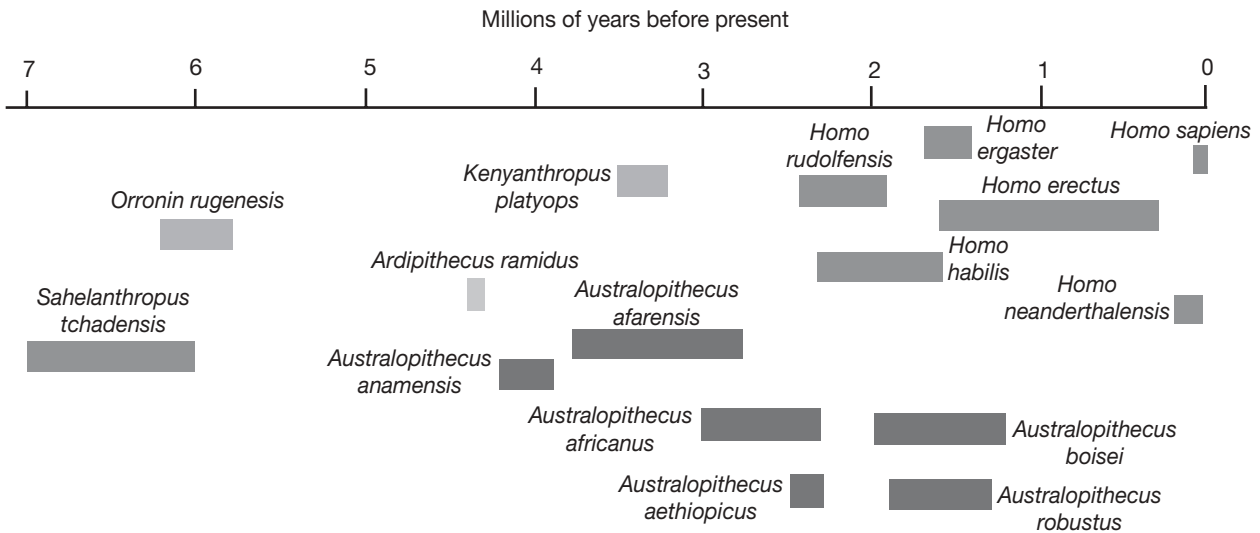
- b.** Compare the survival estimate of the three groups when the children were about four years old (1460 days until death). 2 marks

It was also known that individuals heterozygous for sickle cell anaemia are more likely to survive malaria, which is the world’s most deadly pathogenic disease. Eastern Africa is one of the areas of the world where malaria is a significant problem.

- c. Using your understanding of natural selection, discuss the effect malaria would have on the East African sickle cell gene pool. 3 marks

Question 10 (9 marks)

The evolution of *Homo sapiens* has been linked into the evolutionary tree of hominins, as shown in the diagram below.



- a. i. Define the term ‘hominin’. 1 mark

- ii. How long did *Homo habilis* and *Australopithecus boisei* co-exist? 1 mark

- b. Discuss two reasons why *Sahelanthropus tchadensis* was not found any earlier than six million years before present. 2 marks

- c. Use the diagram to discuss why the presence of *Homo sapiens* and *Homo neanderthalensis* would be an example of divergent evolution. 2 marks

A hominin bone fragment was recently found to be about 500 000 years old. This was a significant discovery because anthropologists were unsure whether it was *Homo sapien* or *Homo erectus* in origin. They eventually concluded that it belonged to *Homo erectus*.

- d. i. Discuss the technique anthropologists would use to determine the absolute age of the bone fragment. 2 marks

- ii. What sort of evidence would the anthropologists look for to conclude that the bone fragment belonged to *Homo erectus* and not *Homo sapiens*? 1 mark

END OF QUESTION AND ANSWER BOOKLET