



Trial Examination 2015

# VCE Biology Units 3&4

Written Examination

## Question and Answer Booklet

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

Student's Name: \_\_\_\_\_

Teacher's Name: \_\_\_\_\_

### Structure of Booklet

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	40	40	40
B	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 34 pages.

Answer sheet for multiple-choice questions.

### Instructions

Write your **name** and your **teacher's name** in the space provided above on this page, and 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.

**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 2015 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.

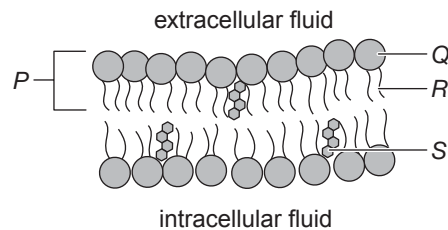
A correct answer scores 1, an incorrect answer scores 0.

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

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

*Use the following information to answer Questions 1 and 2.*

The diagram below shows a cell membrane.

**Question 1**

The component that is hydrophilic is

- A. *P*
- B. *Q*
- C. *R*
- D. *S*

**Question 2**





Components *P* and *S* are located close together.

The best description of the interaction they have with each other is that

- A. the presence of high amounts of *S* prevents *P* from crystallising at low temperatures.
- B. the presence of *P* allows *S* to move from the intracellular fluid to the extracellular fluid.
- C. *S* facilitates the movement of chemicals through the region where *P* is located.
- D. the presence of low amounts of *S* prevents *P* from crystallising at high temperatures.

**Question 3**

The following tables illustrate a variety of organic structures (white blood cell, bacteria, virus and prion). Unfortunately, their respective sizes became mixed up, but a table of the sizes that were calculated is included.

Cell structure	
white blood cell 	prion 
virus 	bacteria 

Size
20 nm
10 nm
20 $\mu\text{m}$
1 $\mu\text{m}$

The correct combination of cellular structure and size would be

- A. white blood cell (20 nm).
- B. bacteria (1  $\mu\text{m}$ ).
- C. virus (20  $\mu\text{m}$ ).
- D. prion (10 nm).

**Question 4**

Condensation polymerisation occurs when

- A. ADP and Pi forms from ATP.
- B. monosaccharides are produced from the breakdown of polysaccharides.
- C. fatty acids are formed by digesting triglycerides.
- D. glucose monomers join to form a starch polymer.

**Question 5**

The three parts of an RNA nucleotide are

- A. ribose sugar, phosphate and nitrogenous base.
- B. pentose sugar, nitrogenous base and deoxyribose.
- C. deoxyribose sugar, phosphate and amino acid.
- D. phosphate, amino acid and pentose sugar.

*Use the following information to answer Questions 6 and 7.*

The following table shows four anticodons and the amino acids they code for.

Anticodon	Amino acid
AAA	phenylalanine
UUU	lysine
GAG	leucine
CUC	glutamine

**Question 6**

An anticodon is located on

- A. tRNA.
- B. rRNA.
- C. mRNA.
- D. a ribosome.

**Question 7**

A DNA template strand has the following sequence

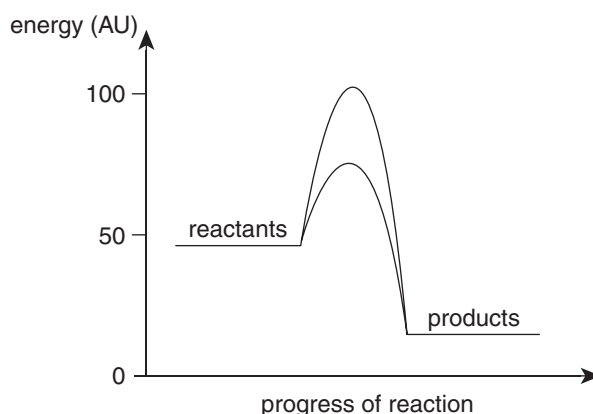
A A A T T T G A G C T C

The amino acid sequence coded for would be

- A. phenylalanine-lysine-leucine-glutamine.
- B. lysine-phenylalanine-glutamine-leucine.
- C. phenylalanine-lysine-glutamine-leucine.
- D. lysine-phenylalanine-leucine-glutamine.

**Question 8**

The energy profile diagram below illustrates a chemical reaction with and without a catalyst.



The energy of activation for the reaction without a catalyst is closest to

- A. 90 AU
- B. 50 AU
- C. 60 AU
- D. 30 AU

**Question 9**

The best way to describe the interaction between an enzyme and a substrate is that the

- A. enzyme is the key and the substrate is the lock.
- B. enzyme has a complementary shape to the substrate.
- C. enzyme has the same shape as the substrate.
- D. enzyme's active site is complementary to the substrate.

**Question 10**

Which one of the following gives a biochemical reaction correctly linked with its corresponding cellular location?

- A. The light-independent reaction occurs within the lumen of the grana inside the chloroplast.
- B. ATP hydrolysis occurs at the ribosomes in the cytosol.
- C. Glycolysis occurs within the matrix of the mitochondria.
- D. The Krebs's cycle occurs within the stroma of the chloroplast.

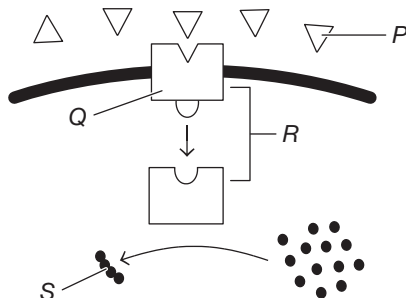
**Question 11**

The difference between a hormonal response when compared to a nervous response is that hormonal responses

- A. are longer lasting than nervous responses.
- B. are directed to the effector, whereas nervous responses are non-specific.
- C. are faster than nervous responses.
- D. stimulate internal change, whereas nervous responses stimulate external changes.

Use the following information to answer Questions 12 and 13.

The diagram below illustrates a cellular process. *P–S* indicate various steps and/or components of the process.



### Question 12

Which one of the following correctly names the steps/components represented by *P–S*?

- A. *P*: receptor; *Q*: secondary messenger; *R*: signalling molecule; *S*: response
- B. *P*: signalling molecule; *Q*: secondary messenger; *R*: receptor; *S*: response
- C. *P*: signalling molecule; *Q*: receptor; *R*: secondary messenger; *S*: response
- D. *P*: receptor; *Q*: second messenger; *R*: response; *S*: secondary messenger

### Question 13

The cellular process illustrated could be a

- A. steroid hormone such as testosterone, leading to a cellular response.
- B. peptide hormone such as insulin, leading to the conversion of glycogen into glucose.
- C. steroid hormone such as oestrogen, activating a gene.
- D. peptide hormone such as insulin, leading to the conversion of glucose into glycogen.

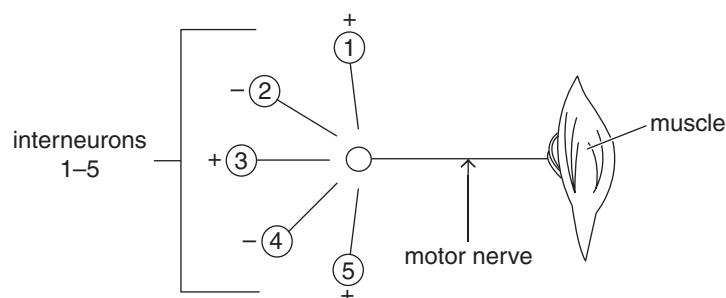
### Question 14

Which one of the following statements correctly combines the idea of signalling molecules and their function?

- A. Signalling molecules are a type of hormone.
- B. Plant growth regulators are a type of signalling molecule.
- C. Pheromones are a type of hormone.
- D. Neurotransmitters are a type of plant growth regulator.

**Question 15**

The diagram below shows the connection that five interneurons have with a single motor neuron. The '+' symbol represents stimulation (leading to muscle contraction) and the '-' symbol represents inhibition (leading to muscle relaxation).



A person accidentally grasped the handle of a hot saucepan.

To release the handle of the saucepan (or to relax the muscle), the sequence of nerves that would be activated would be

- A. 1, 3, 5
- B. 1, 2, 3, 4, 5
- C. 2, 4
- D. 2, 3, 4

**Question 16**

Antibiotics are effective against bacterial, but not viral, diseases because

- A. the antibiotic disrupts the normal metabolism within the bacteria, but not the metabolism within the virus.
- B. viral diseases only cause disease in parts of the host that are not sensitive to antibiotics.
- C. viruses only cause disease within cells, and antibiotics are only effective outside cells.
- D. antibiotics disrupt the metabolism of bacterial cells, and viruses are not metabolically active.

**Question 17**

A chemical barrier in either plants or animals that would help to reduce the impact of pathogenic disease is the

- A. presence of unbroken skin in humans to prevent bacteria from entering into the bloodstream.
- B. presence of epidermal layers of cells both sides of a leaf to prevent aphids gaining access to the sap.
- C. secretion of terpenes from conifers to deter herbivorous insects.
- D. presence of ciliated cells in the lungs to sweep out dust particle.

**Question 18**

The lymphatic system is a

- A. one-way system containing a high concentration of lymphocytes.
- B. two-way system containing a high concentration of lymphocytes.
- C. one-way system that delivers lymphocytes to the site of infection.
- D. one-way system that is comprised entirely of lymph nodes.

**Question 19**

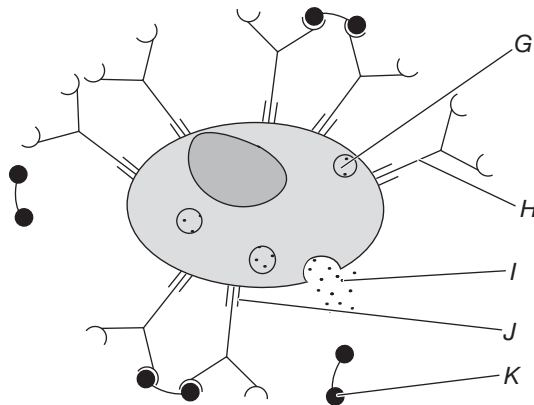
When a recipient receives a transplant, they are given immunosuppressant medication for life. These drugs only suppress the cell-mediated immune system – the parts that would lead to the rejection of the donor organ – leaving the other parts of the immune system to remain functional.

It would be expected that the parts of the immune system which are still active would be most functional against

- A. the formation of cancer cells.
- B. viral diseases.
- C. spider bites.
- D. autoimmune diseases.

**Question 20**

The diagram below shows a mast cell that has been activated to secrete a chemical which will lead to an inflammatory response. Labels *G–K* indicate various components of this type of response.



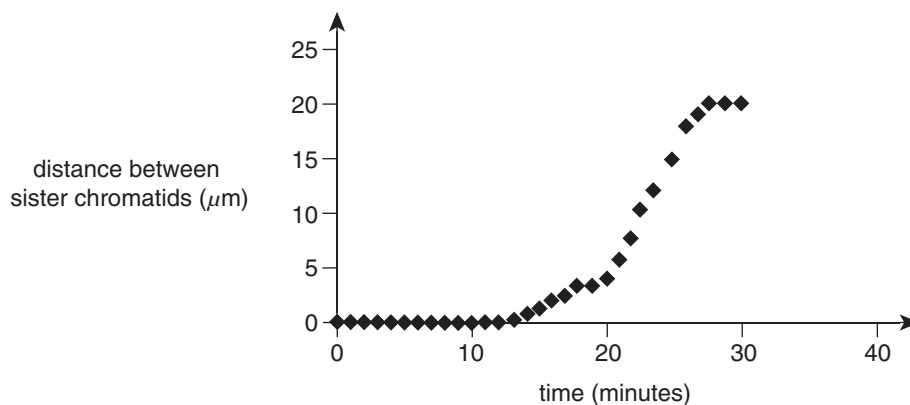
Which one of the following correctly names the components represented by *G–K*?

- A. *G*: vesicle; *H*: antibody; *I*: neurotransmitter; *J*: antibody receptor; *K*: allergen
- B. *G*: vesicle; *H*: antibody; *I*: histamine; *J*: antibody receptor; *K*: allergen
- C. *G*: vesicle; *H*: antibody receptor; *I*: neurotransmitter; *J*: antibody; *K*: allergen
- D. *G*: vesicle; *H*: antibody receptor; *I*: histamine; *J*: antibody; *K*: allergen



**Question 21**

The graph below tracks sister chromatids during one mitotic cycle.



Anaphase begins at

- A. 6 minutes.
- B. 13 minutes.
- C. 25 minutes.
- D. 35 minutes.

**Question 22**

The table below shows the genome size and haploid number of a variety of organisms.

Organism	Genome size (Mb)	Haploid number ( $n$ )
dog	3000	39
onion	15 000	8
human	3000	23
chicken	1200	39
yeast	12	16

Which one of the following statements is consistent with the information in the table?

- A. There is a correlation between the haploid number and genome size.
- B. The dog and the chicken are more similar to each other due to them both having the same haploid number.
- C. The onion would have more genes than the human per diploid cell.
- D. The diploid number of the onion would be the same as the haploid number of yeast.

**Question 23**

Two chromosomes are illustrated below.



These chromosomes would be found in

- A. bacteria undergoing binary fission.
- B. a stem cell during G2 of interphase.
- C. a cell in the second meiotic division.
- D. a cell during meiosis, prior to independent assortment.

*Use the following information to answer Questions 24 and 25.*

A sample of cells was extracted from the amniotic fluid of a sixteen-week-old foetus, and the karyotype below was prepared from a photograph of the cells in metaphase.

**Question 24**

Which one of the following statements is consistent with the karyotype?

- A. There are twenty-three pairs of autosomes.
- B. There are two copies of every gene illustrated in the karyotype.
- C. The individual that the karyotype was constructed from is male.
- D. Each chromosome in the diagram is comprised of one chromatid and one centromere.

**Question 25**

The best explanation for the karyotype shown is that nondisjunction occurred during

- A. meiosis I of the sex chromosomes in the mother only.
- B. meiosis I or II of the sex chromosomes in the father.
- C. meiosis II of one of the sex chromosomes in the father, and during meiosis I of one of the sex chromosomes in the mother.
- D. meiosis II of one the sex chromosomes in the mother.

Use the following information to answer Questions 26–28.

Thirty-three major blood group systems (including the ABO, Rh and MNS systems) were recognised by the International Society of Blood Transfusion in October 2012. The chromosome location of the ABO, Rhesus and MN genes, as well as their genotypes and phenotypes, are listed in the table below.

Location: Chromosome 9		Location: Chromosome 1		Location: Chromosome 4	
ABO type		Rhesus		MN type	
Phenotype	Alleles	Phenotype	Alleles	Phenotype	Alleles
A	$I^A$	positive	R	M	$L^M$
B	$I^B$	negative	r	N	$L^N$
O	i				

### Question 26

An individual with a genotype of  $I^A i R r L^M L^N$  would have which of the following phenotypes?

- A. type A, Rhesus positive, type M
- B. type A, Rhesus negative, type MN
- C. type A, Rhesus positive, type MN
- D. type AB, Rhesus positive, type N

### Question 27

With respect to the three genes given in the table above, how many genotypes are possible?

- A. 7
- B. 12
- C. 14
- D. 54

### Question 28

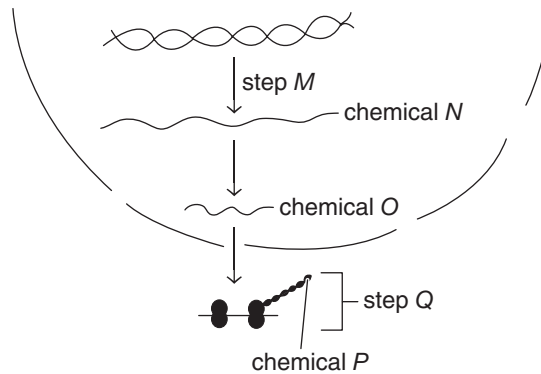
Two individuals have the genotype  $I^A I^B R r$ .

The chance of them conceiving a child that is A negative is

- A. 1 in 16.
- B. 1 in 4.
- C. 1 in 8.
- D. 1 in 2.

**Question 29**

The diagram below illustrates an important cellular process. Labels *M–Q* relate to various steps and/or chemicals involved in the process.



Which one of the following correctly names the steps/chemicals represented by *M–Q*?

- A. *M*: translation; *N*: mRNA; *O*: pre-mRNA; *P*: protein; *Q*: transcription
- B. *M*: transcription; *N*: pre-mRNA; *O*: mRNA; *P*: protein; *Q*: translation
- C. *M*: translation; *N*: pre-mRNA; *O*: mRNA; *P*: protein; *Q*: transcription
- D. *M*: transcription; *N*: mRNA; *O*: pre-mRNA; *P*: protein; *Q*: translation

**Question 30**

Consider the DNA sequence below and the associated list of restriction enzymes with their corresponding recognition sites.

AACTTTAGCCCCGGGAGCACGAATTCGGATGCTTGCTCGATAGCAACGTC  
TTGAAATCGGGGCCACGTGCTTAAGCCTACGAACGAGCTATCGTTGCAG

Restriction enzyme	Binding site
<i>EcoRI</i>	GAATTC
<i>SmaI</i>	CCCGGG
<i>TaqI</i>	TCGA

If the DNA strand shown above was mixed with all three restriction enzymes, how many strands would be formed?

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

**Question 31**

Which of the following statements is most consistent regarding mutations?

- A. They usually occur in the gene section of a genome.
- B. Their rate is set in an unchanging environment.
- C. They will induce a change in phenotype.
- D. They are always detrimental to survival.

**Question 32**

Northern elephant seals have reduced genetic variation within their population compared to southern elephant seal populations. Hunting reduced the northern seal population size to as few as twenty individuals at the end of the nineteenth century, but their population has now grown to over 30 000.

This is an example of

- A. a population bottleneck.
- B. the founder effect.
- C. gene flow.
- D. lethal alleles.

**Question 33**

The map below illustrates the geographic range of marsupials around the world. Placental mammals evolved after marsupials and outcompeted them in most parts of the world. The darker regions represent their current distribution.

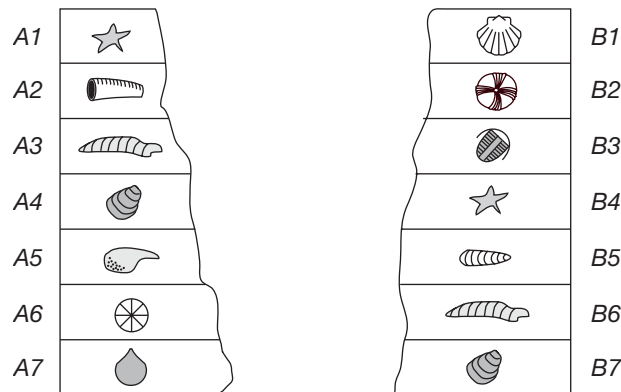


The current distribution of marsupials provides evidence of

- A. biogeography.
- B. placental extinctions.
- C. molecular analogies.
- D. ancestral marsupials being able to swim.

**Question 34**

Stratigraphic correlation can be used to determine the relative ages of fossils, and index fossils can be used to compare the strata from region to region. The diagrams below illustrate the strata layers (1–7) found in two regions (*A* and *B*) that were 100 km apart.



Which of the following statements is most consistent with the information provided above?

- A. Area *B* has the youngest strata layer.
- B. The fossils located in layers *A3* and *B3* could be used as index fossils.
- C. The fossils in layer *A6* could be ancestral to the fossils in layer *A7*.
- D. Area *B* has the oldest strata layer.

**Question 35**

The bat and the eagle are unrelated organisms that evolved flight as a survival advantage independently.

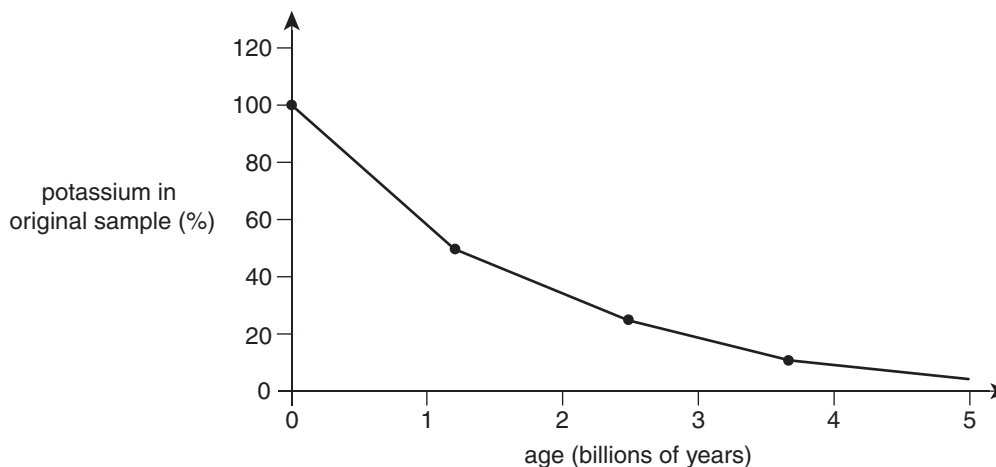


This is an example of

- A. homologous structures.
- B. convergent evolution.
- C. organisms changing to suit their environment.
- D. divergent evolution.

**Question 36**

The graph below can be used to estimate the age of volcanic rock. The amount of potassium in the rock is used as an absolute measure of the age of the rock due to the potassium decaying over time into argon.



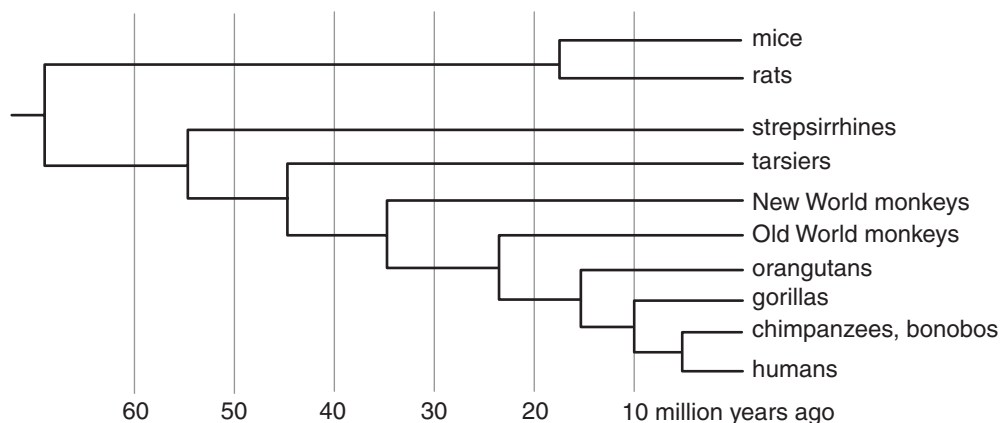
The oldest rocks that have been found on Earth were dated at 4.6 billion years old.

The percentage of potassium present in a sample that is 4.6 billion years old would be closest to

- A. 1.6%
- B. 8%
- C. 46%
- D. 50%

**Question 37**

The cladogram below shows the evolutionary relationships between rodents and primates.



A conclusion which can be made about the cladogram is that

- A. mice and rats are more closely related than orangutans and gorillas.
- B. strepsirrhines and tarsiers diverged more recently than New World and Old World monkeys.
- C. mice and rats diverged about 17 million years ago.
- D. chimpanzees and bonobos belong to the same species.

**Question 38**

It is always difficult to define species. One example is the classification of the Tasmanian snow gum, now known as *Eucalyptus coccifera* (*E. coccifera*). It is rarely found lower than 800 m or higher than 1300 m above sea level. The trees show huge variation in height, known as clinal variation, which initially made them difficult to classify. The table below shows the altitudes and heights of a variety of *E. coccifera* trees found on the side of a mountain in Tasmania's Mount Field National Park.

Altitude (m above sea level)	Average height of <i>E. coccifera</i>
800	40
1000	20
1200	15
1300	10

What evidence would botanists studying these trees find useful in demonstrating that the clinal variation is a consequence of the genotype of the trees at different altitudes, rather than the altitude at which they are located?

- A. Seeds from *E. coccifera* at 800 m, when planted at 800 m, grow to a height of 40 m.
- B. Seeds from *E. coccifera* at 800 m, when planted at 1300 m, grow to a height of 10 m.
- C. Seeds from *E. coccifera* at 1300 m, when planted at 800 m, grow to a height of 10 m.
- D. Seeds from *E. coccifera* from a mixture of altitudes, when planted at sea level, do not germinate.

**Question 39**

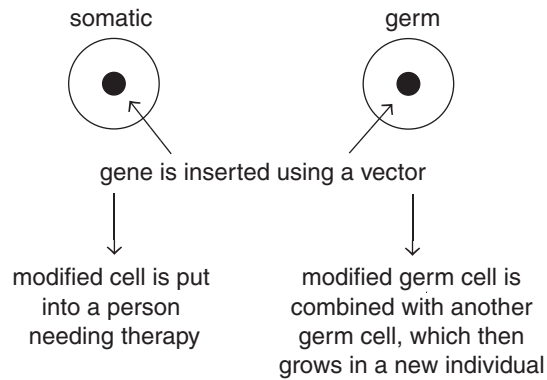
The first hominin that was believed to exploit their environment with prolific tool use was

- A. *Homo sapiens*.
- B. *Homo neanderthalensis*.
- C. *Homo erectus*.
- D. *Homo habilis*.



**Question 40**

There are two main methods for gene therapy. One is referred to as somatic cell gene therapy and the other as germ line gene therapy. The diagrams below illustrate both methods.



When comparing somatic cell gene therapy to germ line gene therapy,

- A. both methods change the genotype of the individual.
- B. somatic cell gene therapy would have fewer side effects than germ line gene therapy.
- C. the somatic cell being modified would have to be a stem cell and the germ-line cell would have to be an ova.
- D. the germ-line cell used for this therapy could be an ova and the somatic cell could be one that is susceptible to the disease within the person needing the therapy.

**SECTION B: SHORT-ANSWER QUESTIONS**

**Instructions for Section B**  
 Answer **all** questions in the spaces provided. Write using black or blue pen.

**Question 1 (7 marks)**

In 2010, the first synthetic cells were manufactured from raw materials. The scientists used *Mycoplasma mycoides* (a bacterium) as the model organism the synthetic cell was constructed from. The steps (A–F) taken to produce the synthetic organism are listed below, but they are not in the correct order.

- A: Allow the bacteria with both the artificial and authentic DNA to divide and produce daughter bacteria, with some containing artificial DNA and some containing authentic DNA.
- B: Synthetically create the DNA from bacterium in the laboratory.
- C: Inject the artificial DNA into a living bacteria with its own authentic DNA.
- D: Decode the DNA from the bacteria.
- E: Add an antibiotic that specifically kills the authentic bacteria, leaving the artificial bacteria unharmed.
- F: Allow the artificial bacteria to express protein.

a. List the steps A–F in the correct order. 1 mark

The following DNA sequence is from the genome of the original *Mycoplasma mycoides*.

**3' G G A C T T A G A 5'**

- b. i. In the box above, write the complementary sequence to the strand given. 1 mark
- ii. Show how this strand of DNA can be replicated. Use a diagram to illustrate your answer. 3 marks

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The synthetic cell is not completely manufactured from spare parts because the original bacterial cells are used in conjunction with the artificial DNA.

- c. A student suggested that the cell is completely synthetic because all the components of the cell rely on the artificial genome to manufacture/replace them.

State one specific aspect of cell structure and/or function that the synthetic genome provides instructions for and explain how the genome controls this aspect.

2 marks

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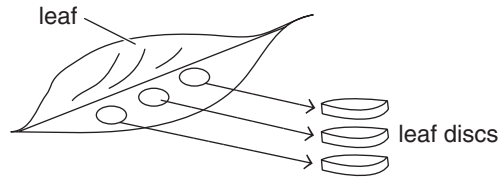
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**Question 2 (5 marks)**

The diagram below shows how leaf discs were obtained as part of an experiment conducted to illustrate the net rate of photosynthesis.



The leaf discs were flooded with bicarbonate ions (a source of carbon for photosynthesis), which makes the discs sink. Once photosynthesis begins, the time it takes for the discs to float is an indirect measure of the net rate of photosynthesis.

- a. Why is the time taken for the leaf discs to float an indirect measure of photosynthesis? 1 mark

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An experiment was conducted testing the effect that temperature had on the time taken for the leaf discs to float. The results are shown below.

Temperature (°C)	Time taken for the leaf discs to float (seconds)
15	480
30	90
45	150
60	480

- b. The results gained at 15°C and 60°C are the same, yet the explanation for them is very different.

Explain these differences.

2 marks

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- c. The 30°C result illustrates the optimum conditions for photosynthesis.

Describe the product(s) and the specific location of the photosynthetic reactions that use

- i. the bicarbonate ions.

1 mark

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- ii. water.

1 mark

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**Question 3 (6 marks)**

Hydrogen peroxide is a toxic by-product of metabolism in most cells. In small amounts, the hydrogen peroxide is lethal to some pathogens (such as bacteria); however, in large amounts, it is toxic to the cell. The use of cellular catalase to break down hydrogen peroxide into oxygen and water is a way to remove raised levels of hydrogen peroxide.

The activity of hydrogen peroxide can be measured by determining the rate of mass loss of a given solution of it when exposed to a variety of conditions. The results of a series of experiments are shown below.

<b>Trial</b>	<b>Conditions</b>	<b>Rate of mass loss (g/min)</b>
1	1% hydrogen peroxide, pH 7, 30°C, 1% catalase	0.75
2	1% hydrogen peroxide, pH 9, 40°C, 1% catalase	1.12
3	0.5% hydrogen peroxide, pH 7, 30°C, 1% catalase	0.50
4	1.5% hydrogen peroxide, pH 7, 30°C, 1% catalase	0.85
5	2% hydrogen peroxide, pH 6, 15°C, 1% catalase	0.65
6	2% hydrogen peroxide, pH 7, 30°C, 1% catalase	0.90
7	4% hydrogen peroxide, pH 7, 30°C, 1% catalase	

- a. i. Which trial(s) (1–6) is/are **unable** to be used to make valid conclusions? 1 mark
- \_\_\_\_\_
- ii. Make a valid conclusion using the remaining results. 1 mark
- \_\_\_\_\_
- \_\_\_\_\_
- iii. Predict a result for trial 7, placing your prediction in the data table. 1 mark

- b.** Design an experiment that would test the hypothesis that at a concentration of less than 0.1%, hydrogen peroxide is lethal to bacteria, but not to the cells that produce it. You are provided with a culture of kidney cells that are not producing hydrogen peroxide **and** have been mixed with a *Streptococcus* bacterial colony.

Include in your answer evidence of the following aspects of experimental design:

- the independent variable
- the dependent variables
- the controlled variables

3 marks

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**Question 4 (7 marks)**

Gibberellic acid (GA) is able to stimulate a wide range of responses in plants depending on the type of cell, the concentration of GA and the presence of other environmental factors, such as water and light.

- a. In terms of signal transduction, explain why the responses to the same GA can be different in different parts of a plant. 2 marks

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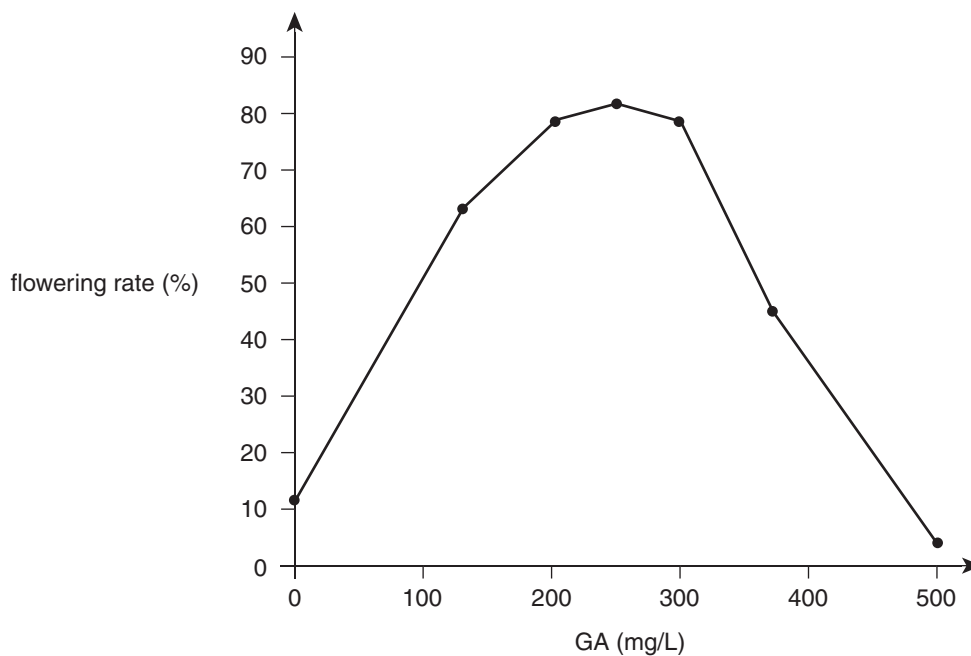


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A study was conducted investigating the effect of changing GA on the flowering of the orchid *Brassocattleya marcella*. The results are graphed below.



- b. i. Predict the flowering rate of an orchid exposed to a GA concentration of 150 mg/L. 1 mark

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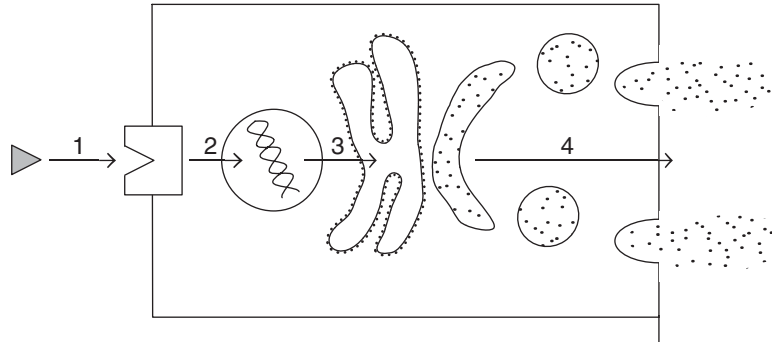
- ii. If a crop of orchids had a flowering rate of 5%, what advice could you give to the orchid cultivator to improve their flowering rate for the next season? 1 mark

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GA is also involved in the germination of seeds by causing the secretion of a chemical that activates starch. The diagram below illustrates the action of GA on the aleurone cells within a seed. Once the GA binds to an external receptor (step 1), there is a cascade of events that leads to a cellular response (steps 2–4).



- c.** Discuss how steps 2 and 3 can lead to a response such as the packaging and secretion of amylase (step 4). 2 marks

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- d.** Discuss the advantage to the germinating seed of a cellular response such as the secretion of amylase. 1 mark

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**Question 5 (5 marks)**

Lung cancer kills too many Australians each year. Research into lung cancer has identified a gene that makes the tumour grow and spread. Hormones bind to a receptor on the FGFR-1 gene in the cancer cell, activating the gene that makes the tumour multiply and spread around the body. If the FGFR-1 receptor is blocked, the cancer cell will undergo the normal programmed death that old, damaged or diseased cells are supposed to go through.

- a. i.** Name the process of normal programmed cell death. 1 mark

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- ii.** Describe a sequence of events that could lead to the process named above. 2 marks

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A drug to switch off the FGFR-1 gene is expected to boost survival rates and revolutionise the way lung cancer is treated.

- b.** Describe how the FGFR-1 gene could be switched off, using the following words in your answer: **receptor**, **RNA polymerase** and **drug**. 2 marks

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**Question 6 (4 marks)**

During 2013 and 2014, antigens from influenza A (H3N2), 2009 influenza A (H1N1), and influenza B (Massachusetts strain) were present in the influenza virus vaccine that was administered to Australian citizens.

- a.** Define the term antigen. 1 mark

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- b.** As a result of a government subsidy, many more people are likely to get vaccinated. Discuss the advantages to the general population when more people get vaccinated. 1 mark

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A person vaccinated against the three strains of influenza contracted an active strain of H1N1 six months after the vaccination.

- c.** Describe the body's response to the H1N1 strain. 2 marks

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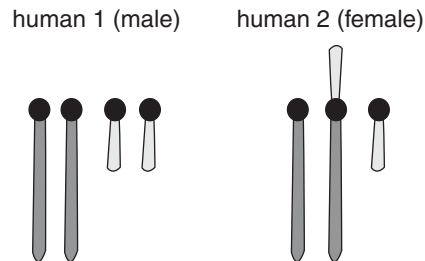
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**Question 7 (5 marks)**

Aneuploidy is a rare condition in humans. Down's syndrome is an example of aneuploidy, where an extra chromosome 21 exists in each of the diploid cells. There are several mechanisms that can lead to this condition. Occasionally, a child with Down's syndrome can be conceived when one of the parents carries a translocation where chromosome 21 joins onto one of the longer chromosomes. This means the parent is a phenotypically normal individual; however, they carry a translocation. The diagram below illustrates a normal chromosomal combination as well as a translocated chromosomal combination. Both combinations lead to normal phenotype.



- a. State the diploid number of a human: 1 mark  
without the translocation.

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with the translocation.

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Occasionally, a situation arises when a person with a normal chromosomal arrangement (such as human 1) has children with a person carrying a translocation like the one in the diagram above (human 2).

- b. In the space below, show all the possible chromosomal arrangements their offspring could display with respect to the chromosomes illustrated. 2 marks

- c. If this couple was concerned about conceiving a baby with Down's syndrome, what advice would you give them, based on your answer to part b.? 2 marks

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**Question 8 (5 marks)**

Siamese cats are sought after as pets. The darker parts of the cats' fur are known as points, which are coded for by two genes. One gene controls hair colour (black (B) being dominant to brown (b)), and the second controls the dilution of the pigment (dense (D) is dominant to dilute (d)). There are four main Siamese cat point colours; seal, chocolate, blue and lilac. The table below shows the genetic inheritance of pointing in Siamese cats.

Phenotype	Genotype(s)
seal	BBDD, BbDD, BBdD, BbDd
chocolate	BBdd, Bbdd
blue	bbDd, bbDD
lilac	bbdd

- a. For a Siamese cat with blue pointing, how many alleles are present in a diploid cell in the G1 phase of interphase for the genes that control this feature? 1 mark

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A cat breeder wishes to find a pair of Siamese cats that are pure breeding for seal points. She has twenty Siamese cats at her disposal: six have seal points, four have chocolate points and ten have lilac points.

- b. Which cat(s) should the cat breeder use in a breeding exercise to determine if any of the cats with seal points are pure breeding? 1 mark

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- c. Show the results of the study that would enable the cat breeder to conclude that she has indeed obtained a pair of Siamese cats that are pure breeding for seal points. In your answer, show the genotypes and phenotypes of the parents and the phenotypes and genotypes of the offspring. 2 marks

- d. One of the remaining chocolate cats reproduced with a lilac cat. Explain what the chance is of a blue Siamese cat appearing in the offspring? 1 mark

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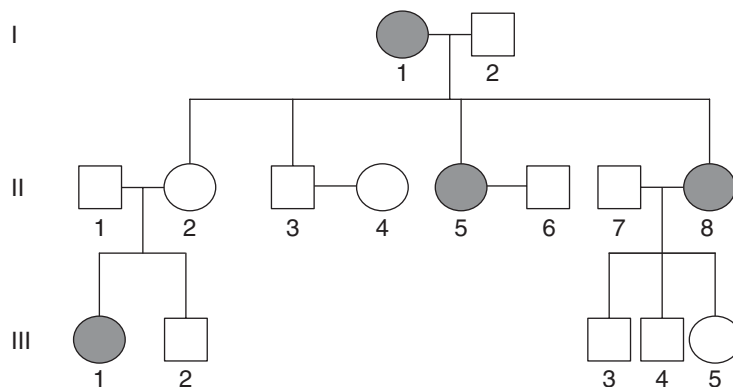


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**Question 9 (6 marks)**

The *BRCA1* and *BRCA2* genes in humans code for tumour-suppressor proteins. Mutations in either of these genes give women a much higher risk of developing breast and (to a lesser degree) other types of cancers. Hundreds of gene mutations have been identified in both of these genes that make genetic testing expensive and unreliable. However, family members of sufferers of breast cancer are the best candidates for successful genetic testing because mutations tend to be passed on.

The following pedigree shows the autosomal dominant inheritance pattern of the *BRCA1* form of breast cancer in a particular family. The shaded individuals have all had breast cancer.



Note: Individuals I2, II1, and II7 were all homozygous.

- a. i. Why does individual II2 not express breast cancer if she is heterozygous? 1 mark

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- ii. What advice would you give individual III5 with respect to her predisposition to breast cancer? 1 mark

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Individuals within this family pedigree that were tested all had a deletion of 244 base pairs in the *BRCA1* gene at exon 5.

- b. Define the term exon. 1 mark

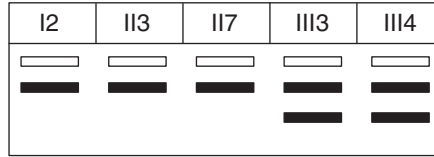
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Exon 5 is normally 1050 base pairs in length and can be spliced out of the *BRCA1* gene using the restriction enzyme *AluI*.

The faulty *BRCA1* gene can be passed on by males to their daughters, so individual III4 wanted to find out if he was a potential carrier of the mutation. His (and other family members) DNA samples were taken, and exon 5 was amplified and restricted with *AluI*. The samples were then loaded into a gel and the subsequent band patterns used to determine their genetic status.



- c. Use the results indicated from the gel above to discuss the genetic status of individual III4. 2 marks

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- d. Discuss one disadvantage of conducting biotechnology research such as testing for breast cancer. 1 mark

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**Question 10 (8 marks)**

There are about twenty bandicoots (extinct or not) in the same family, *Peramelidae*. They share the similar features of long, pointed snouts and small ears. The eastern barred bandicoot, *Perameles gunnii*, and southern brown bandicoot, *Isodon obesulus*, are currently found in the wild, but are under threat of extinction because of habitat destruction.

- a.** Why would a particular organism be described as being extinct? 1 mark

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- b.** All bandicoots are marsupial and started diverging into the different bandicoot species about 18 million years ago.

- i.** What fossil evidence would be required to support this time of divergence? 2 marks

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- ii.** What DNA hybridisation evidence would be required to support this time of divergence? 2 marks

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- c.** Describe the speciation events that have led to the modern eastern barred bandicoot and the southern brown bandicoot. 3 marks

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**Question 11 (7 marks)**

The remains of teeth from one of our *hominin* ancestors suggests the popular ‘Out of Africa’ hypothesis needs revising.

**a. i.** Define the term *hominin*. 1 mark

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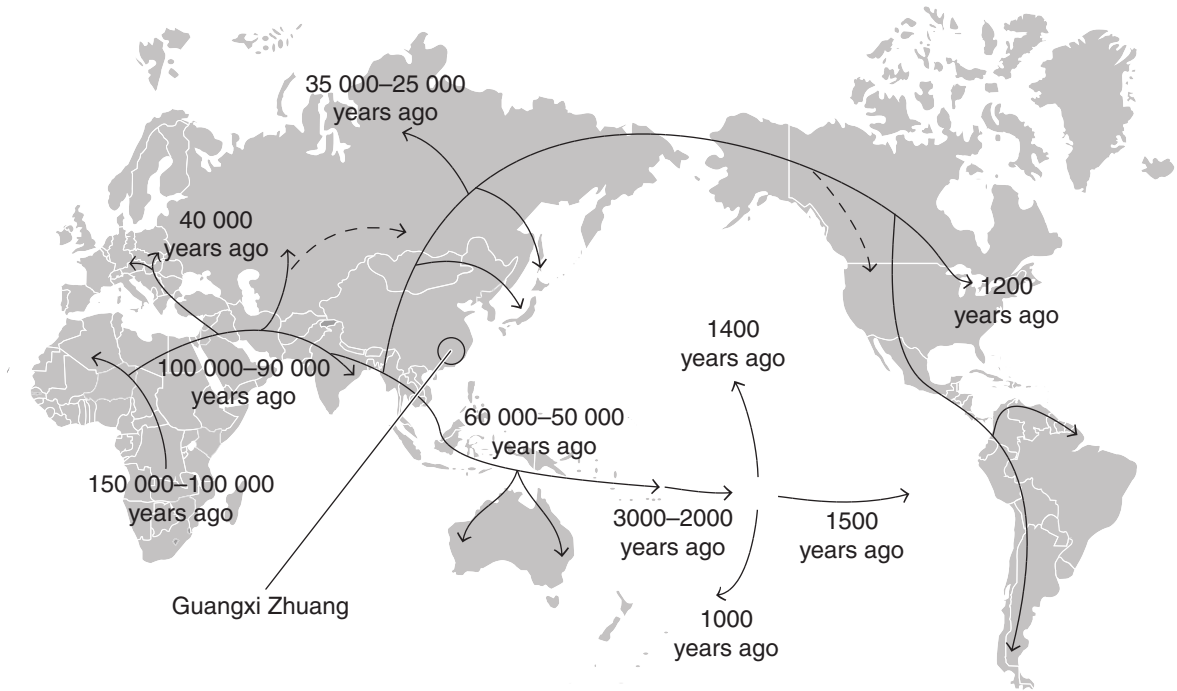
**ii.** In terms of human migrations, what does the ‘Out of Africa’ hypothesis mean? 1 mark

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The map below shows the currently accepted *hominin* migration patterns and the number of years ago these migrations occurred, based on the evidence available at the time. The teeth discovered were about 130 000 years old and were discovered in a region of China called Guangxi Zhuang (the location is illustrated within the circle on the map below).



**b.** Mark on the map which area of the world would contain *hominins* with the most similarity in their mtDNA, and explain your choice. 2 marks

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- c.** How could radioisotopic testing determine the absolute age of the teeth? 2 marks

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- d.** Propose a hypothesis that could account for a 130 000-year-old fossilised *hominin* tooth in Guangxi Zhuang. 1 mark

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**Question 12 (5 marks)**

Stem cell technology has made many new breakthroughs. One of the most notable of these is the effort to create human hearts which can be used for transplants. The cardiac stem cells used in this case were derived from turning human skin cells into adult stem cells, which were then turned into cardiac stem cells.

- a. Discuss the difference between the proteomes of the cardiac stem cells and the skin cells. 1 mark

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A previous study used human embryonic cells to achieve similar results, but the success rate in converting them to beating heart cells was very low.

- b. Other than the success rate, discuss the benefit of using adult stem cells rather than embryonic cells in these studies. 1 mark

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The main challenge in this research is in scaling it up so that a human-sized heart can be manufactured. The other issues that lie ahead for researchers are the sculpting and specialisation required for a fully functional human heart. A small amount of success has been gained by using a ‘heart framework’ that the cardiac stem cells can be grown on.

- c. i. State the name of the process occurring when one cardiac stem cell divides. 1 mark

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- ii. Use the terms **genome** and **differentiation** to illustrate how the initial cardiac stem cells would appear after being left on the ‘heart framework’ for an extended period of time. 2 marks

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**END OF QUESTION AND ANSWER BOOKLET**