



2012 BIOLOGY

**FOR OFFICE
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**ATTACH SACE REGISTRATION NUMBER LABEL
TO THIS BOX**

**QUESTION
BOOKLET**

1

27 pages, 29 questions

Monday 5 November: 9 a.m.

Time: 3 hours

Section A and Part 1 of Section B

Examination material: Question Booklet 1 (27 pages)
Question Booklet 2 (9 pages)
Question Booklet 3 (8 pages)
one multiple-choice answer sheet
one SACE registration number label

Approved dictionaries and calculators may be used.

Instructions to Students

- You will have 10 minutes to read the paper. You must not write in your question booklets, or on your multiple-choice answer sheet, or use a calculator during this reading time but you may make notes on the scribbling paper provided.
- This paper is in three sections: Section A and Part 1 of Section B are in Question Booklet 1; Part 2 of Section B is in Question Booklet 2; and Section C is in Question Booklet 3.

Section A: Multiple-choice Questions (Questions 1 to 25)
Answer Section A on the separate multiple-choice answer sheet, using black or blue pen.
Answer **all** questions in Section A.

Section B: Short-answer Questions (Questions 26 to 34)
Answer Part 1 of Section B (Questions 26 to 29) in the spaces provided in Question Booklet 1.
Write on page 27 of Question Booklet 1 if you need more space.
Answer Part 2 of Section B (Questions 30 to 34) in the spaces provided in Question Booklet 2.
Write on page 9 of Question Booklet 2 if you need more space.

Section C: Extended-response Questions (Questions 35 and 36)
Answer **both** questions in Section C in Question Booklet 3.
Write on page 8 of Question Booklet 3 if you need more space.
- In Section B there is no need to fill all the space provided; clear, well-expressed answers are required. If you delete part or all of an answer you should clearly indicate your final answer and label it with the appropriate question number.
- The allocation of marks and suggested allotment of time are as follows:

Section A	50 marks	40 minutes
Section B	120 marks	110 minutes
Section C	30 marks	30 minutes
Total	200 marks	180 minutes
- Attach your SACE registration number label to the box at the top of this page. Copy the information from your SACE registration number label into the boxes on your multiple-choice answer sheet and on the front covers of Question Booklets 2 and 3.
- At the end of the examination, place Question Booklets 2 and 3, and your multiple-choice answer sheet, inside the back cover of Question Booklet 1.

**STUDENT'S DECLARATION ON THE USE OF
CALCULATORS**

By signing the examination attendance roll I declare that:

- my calculators have been cleared of all memory
- no external storage media are in use on these calculators.

I understand that if I do not comply with the above conditions for the use of calculators I will:

- be in breach of the rules
- have my results for the examination cancelled or amended
- be liable to such further penalty, whether by exclusion from future examinations or otherwise, as the SACE Board of South Australia determines.

SECTION A: MULTIPLE-CHOICE QUESTIONS (Questions 1 to 25)

(50 marks)

Answer **all** questions in this section.

Each of the twenty-five multiple-choice questions in Section A involves choosing from four alternative answers. Read each question carefully. Then indicate the **one** alternative that you consider best answers the question by shading the bubble by the appropriate letter alongside the question number on the multiple-choice answer sheet. Use black or blue pen. It is in your interest to give an answer to every question in this section of the paper, as no marks are deducted for incorrect answers. Each question is worth 2 marks. You should spend about 40 minutes on this section.

1. Which one of the following compounds is a macromolecule that is used as an energy reserve in some plant tissues?
 - J. Glucose.
 - K. Cellulose.
 - L. Oil.
 - M. Glycogen.

2. The specificity of an enzyme for its substrate is determined by the
 - J. temperature at which the enzyme is operating.
 - K. concentration of the substrate.
 - L. active site of the substrate molecule.
 - M. structure of the enzyme molecule.

3. A gene codes for
 - J. complementary base pairs on DNA molecules.
 - K. an RNA molecule.
 - L. sequences of polypeptides on DNA molecules.
 - M. an amino acid molecule.

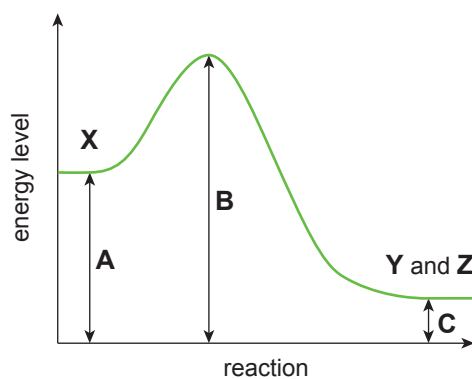
4. Refer to the following table, which shows *mRNA codons* for amino acids:

First base in sequence ↓	Second base in sequence				Third base in sequence ↓
	U	C	A	G	
U	phenylalanine phenylalanine leucine leucine	serine serine serine serine	tyrosine tyrosine — —	cysteine cysteine tryptophan —	U C A G
C	leucine leucine leucine leucine	proline proline proline proline	histidine histidine glutamine glutamine	arginine arginine arginine arginine	U C A G
A	isoleucine isoleucine isoleucine methionine	threonine threonine threonine threonine	asparagine asparagine lysine lysine	serine serine arginine arginine	U C A G
G	valine valine valine valine	alanine alanine alanine alanine	aspartic acid aspartic acid glutamic acid glutamic acid	glycine glycine glycine glycine	U C A G

The base sequence **U A U** on

- J. tRNA codes for tyrosine.
- K. mRNA codes for isoleucine.
- L. DNA codes for tyrosine.
- M. tRNA codes for isoleucine.

5. Refer to the following graph, which shows the energy changes that occur in the reaction in which molecule **X** breaks down into molecules **Y** and **Z** in the presence of an enzyme:



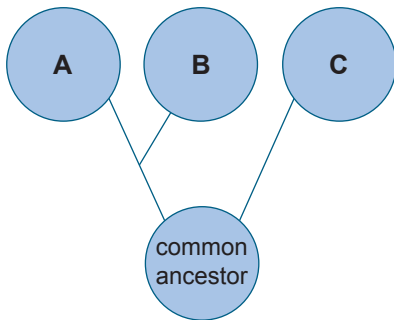
The activation energy for this reaction is equal to

- J. **B – A.**
- K. **A + B.**
- L. **A.**
- M. **B – C.**

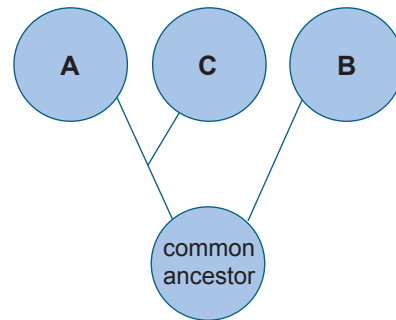
6. *Cytochrome c* is a protein found in most organisms. The amino acid sequence of this protein varies between different species and can be used to determine evolutionary relationships. Refer to the following table, which shows the numbers of differences in the amino acid sequences of cytochrome *c* between three species (A, B, and C):

	Species B	Species C
Species A	8	2
Species B	0	9

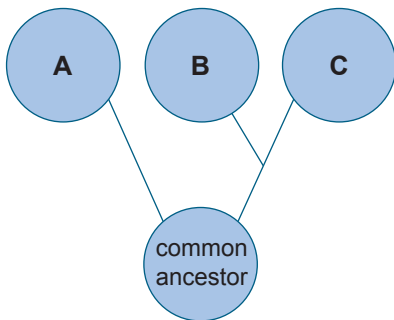
Which one of the following diagrams best represents the evolutionary relationships between species A, species B, and species C?



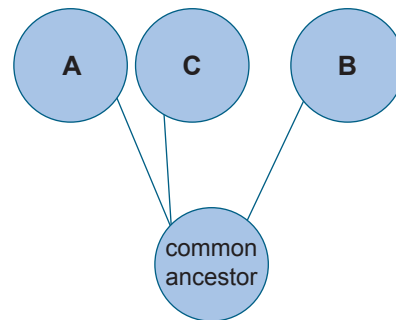
J.



K.



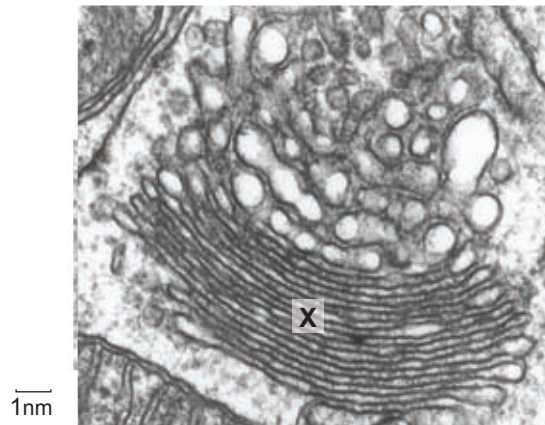
L.



M.

7. Before the onset of cell division the
- J. strands in a DNA molecule separate so that each daughter cell will receive one strand.
 - K. amount of DNA in the cell doubles.
 - L. amount of DNA in the cell halves.
 - M. DNA molecule breaks into two halves so that each daughter cell will receive one half.

8. Refer to the following electron micrograph, which shows organelle X in a cell:



Source: Department of Anatomical Science, University of Adelaide

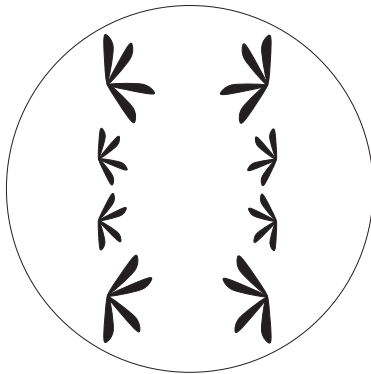
Organelle X is

- J. the site of protein synthesis.
- K. involved in the packaging of molecules.
- L. the site of lipid synthesis.
- M. involved in the storage of molecules.

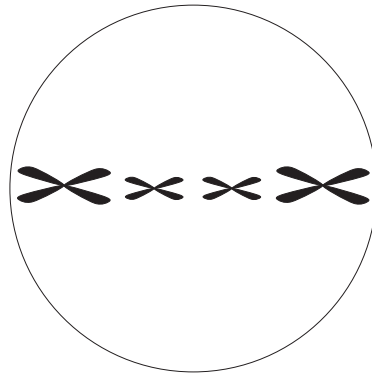
9. Which one of the following statements is **not** evidence for endosymbiotic events in the evolution of eukaryotic cells from prokaryotic cells?

- J. Chloroplasts have a double membrane.
- K. The inner mitochondrial membrane contains phospholipids.
- L. Mitochondria are able to self-replicate.
- M. Both chloroplasts and mitochondria contain their own DNA.

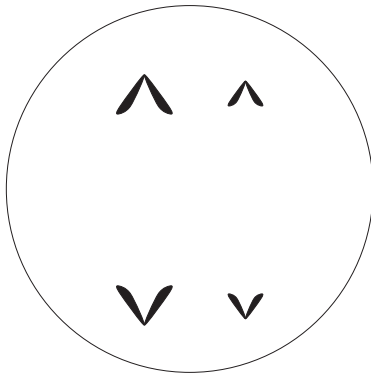
10. Which one of the following diagrams represents a cell that has a diploid number of 4 and is undergoing mitosis?



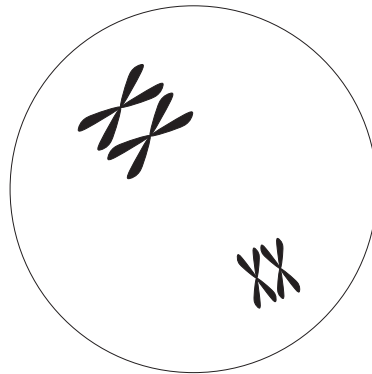
J.



K.



L.



M.

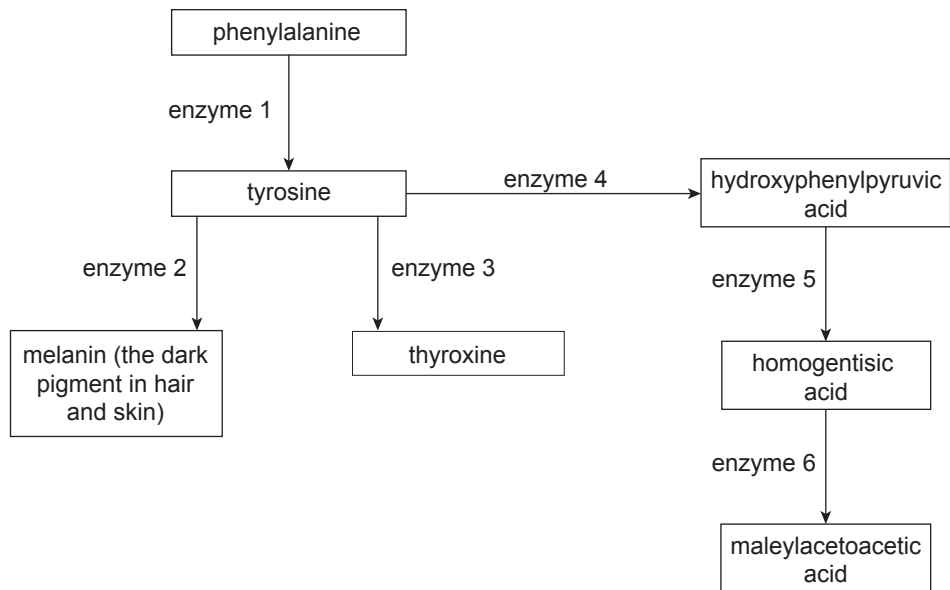
11. A group of biology students performed an experiment in which they investigated the effect of sucrose solutions of different concentrations on the mass of strawberries. Three individual strawberries were weighed and then each one was put in a sucrose solution of different concentration for 30 minutes. The strawberries were then reweighed. The results are shown in the table below:

Strawberry	Mass before (g)	Mass after (g)	Change in mass (g)
A	2.05	2.15	+0.10
B	1.75	1.35	-0.40
C	3.10	3.05	-0.05

Assuming that the initial internal composition of each strawberry was the same, which one of the following statements is consistent with the data above?

- J. Strawberry **C** was put in a sucrose solution of lower concentration than was Strawberry **A**.
- K. Strawberry **A** was put in a sucrose solution of higher concentration than was Strawberry **B**.
- L. Strawberry **B** was put in a sucrose solution of higher concentration than was Strawberry **C**.
- M. Strawberry **B** was put in the sucrose solution of lowest concentration.

12. Refer to the following diagram, which shows part of a metabolic pathway in a human cell:

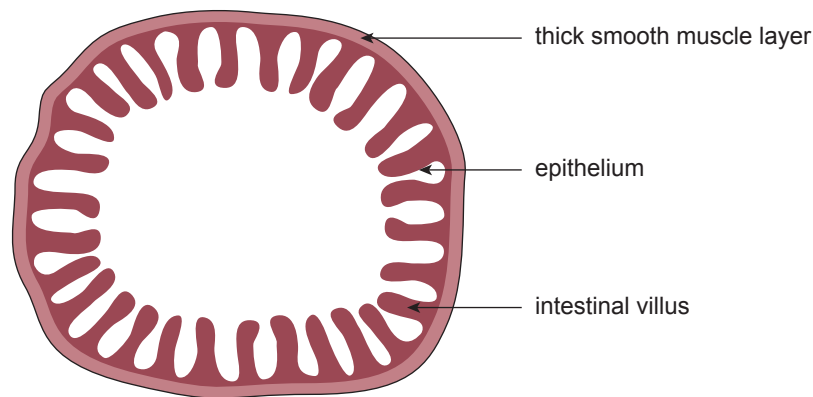


Two genetic metabolic diseases are associated with this pathway: phenylketonuria and alkaptonuria. People with phenylketonuria accumulate phenylalanine. People with alkaptonuria accumulate homogentisic acid. The presence of homogentisic acid in their urine causes it to turn black when exposed to air.

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

- J. People with alkaptonuria lack enzyme 6.
- K. People with phenylketonuria lack enzyme 2.
- L. People with phenylketonuria and people with alkaptonuria lack thyroxine.
- M. People with alkaptonuria usually have light-coloured hair.

13. Refer to the following diagram, which shows a cross-section of the small intestine of a healthy human being:

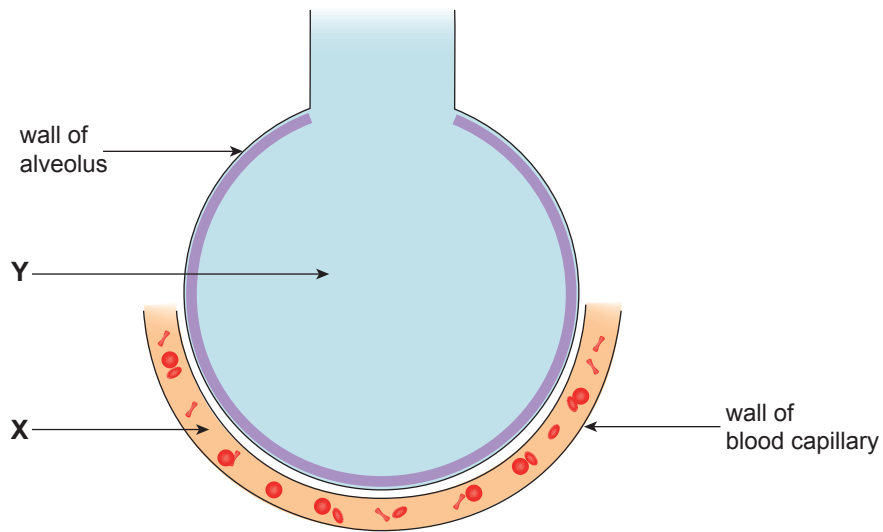


[This diagram is not drawn to scale.]

The small intestine is

- J. a tissue with several types of genetically identical cells.
 - K. an organ with tissues of like form and function.
 - L. an organ with several types of genetically identical tissues.
 - M. a tissue with cells of like form and function.
14. Which one of the following statements describes a process that does **not** require the expenditure of cellular energy?
- J. The synthesis of proteins in the cytoplasm.
 - K. The separation of chromatids during cell division.
 - L. The entry into a lymph capillary of water from the surrounding tissue.
 - M. The repair of mutations in DNA by enzymes.

15. Refer to the following diagram, which shows an alveolus:



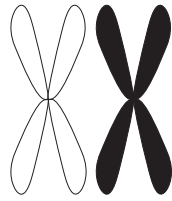
Which one of the following combinations identifies the net movement of a gas across the wall of the alveolus?

	Gas	Moves from	Moves to	Mode of transport
J.	oxygen	Y	X	passive
K.	oxygen	X	Y	active
L.	carbon dioxide	X	Y	active
M.	carbon dioxide	Y	X	passive

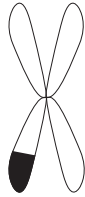
16. Which one of the following changes is most likely to occur when the blood pressure in the kidney is decreased?

- J. A decrease in the rate of filtration of blood in the glomerulus.
- K. An increase in the reabsorption of protein in the tubules.
- L. A decrease in the rate of filtration of water into the blood capillaries.
- M. An increase in the reabsorption of urea in the tubules.

17. Refer to the following diagram, which shows a homologous pair of chromosomes before crossing over occurs:



Which one of the following diagrams best represents a possible result of a single crossing-over event?



J.



K.



L.



M.

18. Refer to the following photograph, which shows the Australian plague locust, *Chortoicetes terminifera*. This species of insect can form swarms of millions of individuals, which cause large-scale damage to crops. To reduce the population of these swarms, insecticides are sprayed onto the insects.



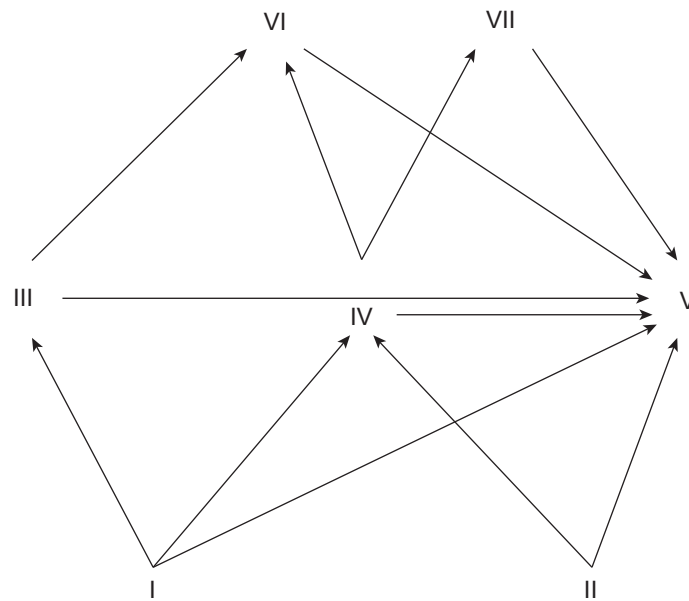
Source: © Blagov58/Dreamstime.com

A population of Australian plague locusts is regularly sprayed with an insecticide.

The long-term survival of the population results from individual locusts that

- J. develop an immunity to the insecticide.
 - K. learn to shelter from the insecticide.
 - L. inherit resistance to the insecticide from their parents.
 - M. adapt to the presence of the insecticide.
19. In the nineteenth century Louis Pasteur showed that fermentation by bacteria can contaminate wine.
- The process of fermentation in bacteria occurs in the
- J. mitochondria in the absence of oxygen.
 - K. cytoplasm in the presence of oxygen.
 - L. mitochondria in the presence of oxygen.
 - M. cytoplasm in the absence of oxygen.
20. Which one of the following statements mentions only one species?
- J. Two different breeds of dog are able to produce viable offspring.
 - K. A red kangaroo (*Macropus rufus*) and a grey kangaroo (*Macropus giganteus*) live in the same area.
 - L. A koala eats a leaf from a eucalyptus tree.
 - M. A tiger and a lion are able to breed and produce an infertile liger.

21. Refer to the following diagram of a food web in which the arrows represent the flow of energy:



Which one of the following alternatives identifies the producer(s) in this food web?

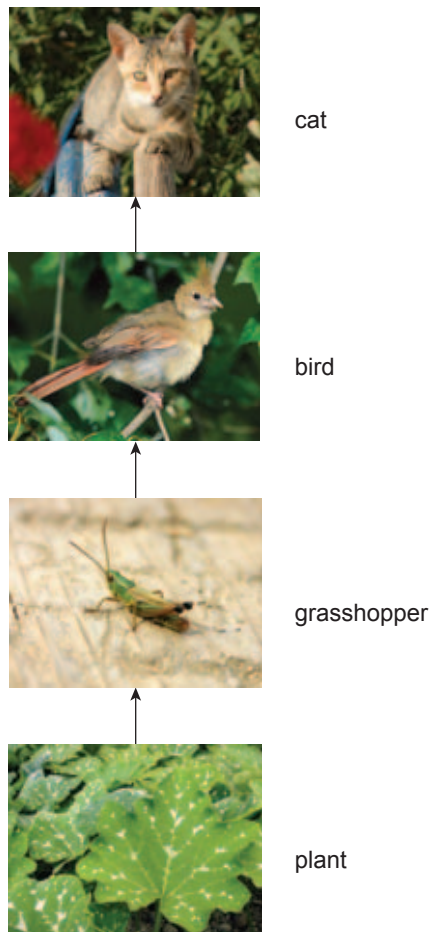
- J. VI and VII.
- K. V only.
- L. III and IV.
- M. I and II.

22. Fossils of the 'dawn monkey' (*Eosimias sinensis*) were found in China in 1994. There is evidence that they were ancestors of present-day monkeys. This suggests that monkeys may have originated in Asia, not Africa.

Which one of the following statements identifies the process by which a new species of monkey may have evolved from the dawn monkey?

- J. Environmental pressures caused some dawn monkeys to adapt and change until they were reproductively isolated.
- K. A mutation that appeared in a dawn monkey prevented it from interbreeding with the rest of the population.
- L. A group of dawn monkeys was geographically isolated and only those that adapted to a new food source were able to survive.
- M. A group of dawn monkeys was geographically isolated and different environmental pressures over many generations resulted in changes to the breeding season.

23. Refer to the following food chain, which shows four trophic levels:



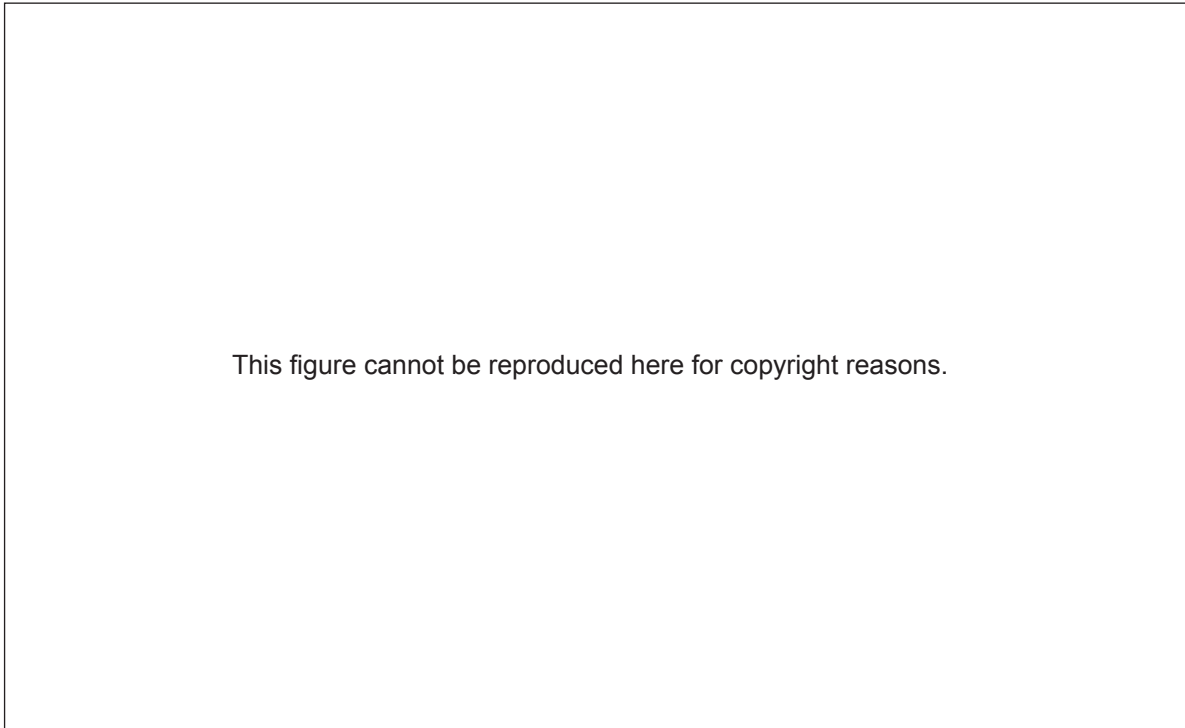
Sources: Plant © Jenny King/Dreamstime.com. Grasshopper © Roman Milert/Dreamstime.com.
Bird © Anthony Hathaway/Dreamstime.com. Cat © Robert Lerich/Dreamstime.com.

Each year 2000 000 kilojoules of energy per square metre is incorporated in this food chain.

Which one of the following statements best describes what will happen to the energy that is incorporated in the food chain?

- J. About 10% of the energy will be passed along at each trophic level until decomposers recycle it.
- K. Most of the energy will be lost as heat.
- L. All of the energy will eventually be transferred to decomposers.
- M. About 2000 kilojoules per square metre per year will be lost as waste material.

24. Refer to the following diagram, which shows the net primary productivity of various ecosystems:

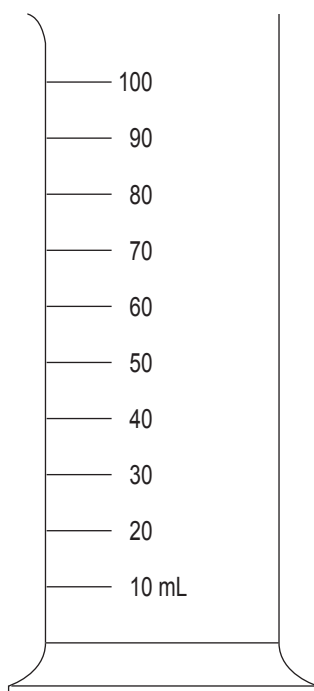


Source: Adapted from web.bryant.edu

Which one of the following statements best explains the information in the diagram above?

- J. Deserts have a lower net primary productivity than boreal forests because of their higher levels of light intensity.
- K. Cold deciduous forests and warm temperate mixed forests have the same net primary productivity because identical resources are available to them.
- L. Tropical rainforests have a higher net primary productivity than grasslands because of their biodiversity.
- M. Salt marshes have a higher net primary productivity than cultivated land because of their faster growth rates.

25. Refer to the following diagram, which shows the measuring cylinder used by three students (A, B, and C) to measure the volume of a liquid:



Each student took three readings of the volume of the liquid and calculated an average, as recorded in the table below:

Student	Volume (mL)			Average
	Reading 1	Reading 2	Reading 3	
A	52	53	52	52.3
B	50.0	50.1	49.9	50
C	40	50	50	47

Taking into account the resolution of the measuring cylinder, which one of the following statements is correct?

- J. Student **A** recorded appropriate readings but calculated an inappropriate average.
- K. Student **B** recorded appropriate readings and calculated an appropriate average.
- L. Student **C** recorded appropriate readings and calculated an appropriate average.
- M. Student **B**'s data are more appropriate than Student **A**'s.

SECTION B: SHORT-ANSWER QUESTIONS (Questions 26 to 34)

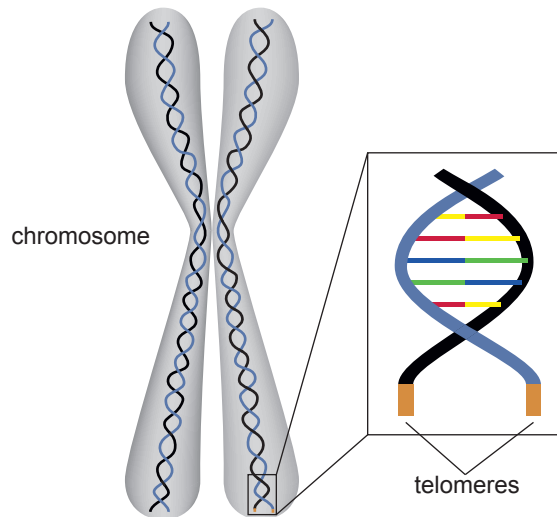
(120 marks)

You should spend about 110 minutes on this section. Answers may be in note form. The allocation of marks is shown in brackets at the end of each part of each question. Answer **all** questions in the spaces provided.

PART 1 (Questions 26 to 29)

(60 marks)

26. Refer to the following diagram, which shows a human chromosome. The ends of chromosomes contain repeating base sequences called 'telomeres'. Each time the DNA in chromosomes replicates, the telomeres shorten. After a certain number of cell divisions the telomeres become too short for further DNA replication to occur. Evidence suggests that human beings age as a result of the shortening of their telomeres.



- (a) Explain why the replication of a DNA molecule is called 'semi-conservative'.

(4 marks)

According to recent studies an enzyme called 'telomerase' is responsible for repairing and lengthening the telomeres of human chromosomes. In high concentrations, telomerase increases the number of cell divisions that occur in a human being and as a result may prolong a person's life. Abnormally high concentrations of telomerase are found in cancer cells.

- (b) Describe the process that occurs in the **nucleus** of a human cell, and that enables the telomerase enzyme to be produced.

(4 marks)

- (c) Describe how a mutation of the gene that **regulates** the production of telomerase may cause a cell to become cancerous.

(4 marks)

- (d) State one factor that may increase the rate of mutation in the DNA of organisms.

(2 marks)

- (e) The use of chemicals that inhibit the telomerase enzyme may prove to be a successful way of controlling cancer.

Explain how a chemical inhibitor may reduce the activity of the telomerase enzyme.

(4 marks)

- (f) A telomerase-enhancing drug is commercially produced and sold at a cost of up to several thousand dollars per year, to people who want to prolong their life.

State one negative **social** consequence of the use of the telomerase-enhancing drug.

(2 marks)

27. Healthy human beings produce antithrombin (AT), a protein that prevents blood from clotting in blood vessels. A small percentage of people are affected by a rare disease that prevents them from producing AT. The absence of AT in the blood can result in blood clots, which sometimes cause death.

Scientists have genetically engineered goats to produce the human AT protein in their milk, which can then be given to people who lack AT.

(a) Describe how a segment of DNA containing the human AT gene can be selected.

(4 marks)

(b) State why **many copies** of the human AT gene are introduced into a fertilised goat egg when scientists attempt to produce a genetically engineered goat.

(2 marks)

(c) Name the type of cell division that ensures that all the cells of a genetically engineered goat receive the human AT gene.

(2 marks)

(d) State one reason why the milk from the genetically engineered goats should be labelled 'genetically modified'.

(2 marks)

(e) Genetically engineered goats can be bred to produce offspring.

Ignoring the effect of mutation, explain why the offspring of two genetically engineered goats are not all genetically identical.

(4 marks)

(f) The polymerase chain reaction (PCR) is a process that scientists use to produce many copies of a segment of DNA. PCR involves the repeated heating and cooling of DNA to a temperature of more than 90° Celsius.

Explain why the human enzyme DNA polymerase cannot be used in the process of PCR.

(4 marks)

28. There are several processes by which materials enter cells.

- (a) Describe one process in which the cell membrane forms vesicles (membrane-bound structures) to transport materials **into** a cell. You may use a labelled diagram.

(4 marks)

- (b) Using the fluid mosaic model, describe the structure of the membrane of a vesicle. You may use a labelled diagram.

(4 marks)

29. Plants are often grown commercially in the controlled environment of a greenhouse such as the one shown below:



Source: © Peanutoas.../Dreamstime.com

Plant growers want their crops to grow quickly and they will often artificially increase the concentration of carbon dioxide in the greenhouse air during the day to about 0.100%, compared with the normal level of about 0.034%. In cooler weather the greenhouses are heated. The rate of photosynthesis can change in patterns similar to those shown in the table of results below:

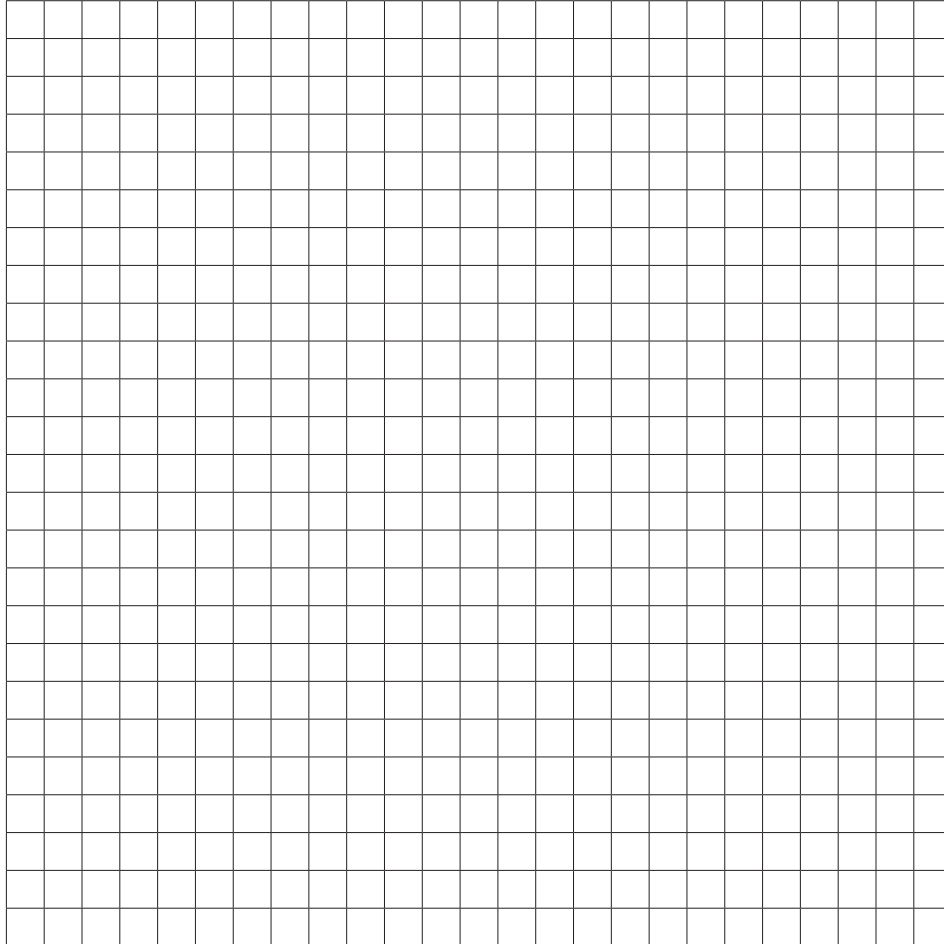
Concentration of CO ₂ in the greenhouse air (%)	Relative rate of photosynthesis	
	At 20°C	At 35°C
0.005	20	23
0.020	80	95
0.034 (normal level of CO₂)	100	110
0.060	110	120
0.090	117	123
0.120	117	123

(a) Write a balanced chemical equation for photosynthesis.

_____ (2 marks)

(b) Using the data in the table on the page opposite:

- plot two graphs on the same set of axes on the grid below
- draw two lines of best fit to show the effect of the concentration of CO₂ in the greenhouse air on the relative rate of photosynthesis at the two temperatures.



(6 marks)

(c) State one reason why the relative rate of photosynthesis does not increase when the concentration of CO₂ in the greenhouse air exceeds 0.090%.

(2 marks)

- (d) Explain why the concentration of carbon dioxide in the greenhouse air increases at night, even though none is artificially added at this time.

(4 marks)



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External Examination 2012

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BIOLOGY									

QUESTION BOOKLET
2
9 pages, 5 questions

Monday 5 November: 9 a.m.

Part 2 of Section B

Write your answers to Part 2 of Section B in this question booklet.

SECTION B: SHORT-ANSWER QUESTIONS

PART 2 (Questions 30 to 34)

(60 marks)

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

30. Haemodialysis is a process used to artificially remove waste substances, such as urea, from the blood of patients with kidney disease. During haemodialysis the patient's blood flows through a machine containing a membrane that is surrounded by dialysis fluid. The composition of dialysis fluid is similar to that of blood plasma, as shown in the table below:

Substance	Composition of blood plasma as it enters the nephron	Composition of dialysis fluid before haemodialysis	Composition of dialysis fluid after haemodialysis
water	91.5	92.0	96.0
protein	7.0	0.0	0.0
glucose	0.10	0.10	0.10
sodium	0.29	0.29	0.29
urea	0.03	0.00	0.02

- (a) State why protein is not found in the dialysis fluid after haemodialysis.

(2 marks)

- (b) State the name of the process by which each of the following substances moves across the dialysis membrane.

Water: _____ (2 marks)

Urea: _____ (2 marks)

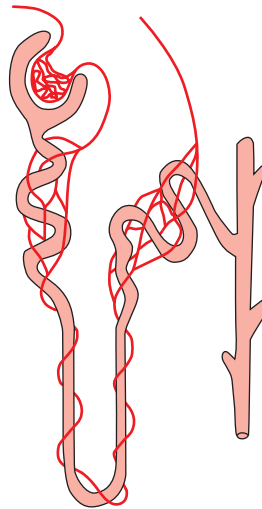
- (c) By referring to the composition of dialysis fluid before and after haemodialysis, explain how haemodialysis removes urea from the blood.

(4 marks)

(d) Explain why dialysis fluid is manufactured with a glucose concentration of 0.10%.

(4 marks)

(e) Refer to the following diagram, which shows the nephron in the kidney:



(i) On the diagram above, write the letter **H** to show the location in the nephron where urea is removed from the blood of a person without kidney disease.

(2 marks)

(ii) State the name of a process that is important to the function of the nephron, and that does not occur during haemodialysis.

(2 marks)

31. 'Fever' is a medical term for a body temperature higher than about 37.5°C in human beings. Fever can occur when prostaglandin E2 (PGE2) is released by the body. PGE2 causes the temperature regulation centre of the brain to reset the body's 'normal' temperature to above 37.5°C. When this happens, the body will respond as if it was feeling colder than normal, even if the body temperature is already 37.5°C.

(a) State the change in body temperature that occurs in response to the release of PGE2.

_____ (2 marks)

(b) Resetting the body's normal temperature to above 37.5°C triggers a hormonal response. Describe this response and its effect on the body.

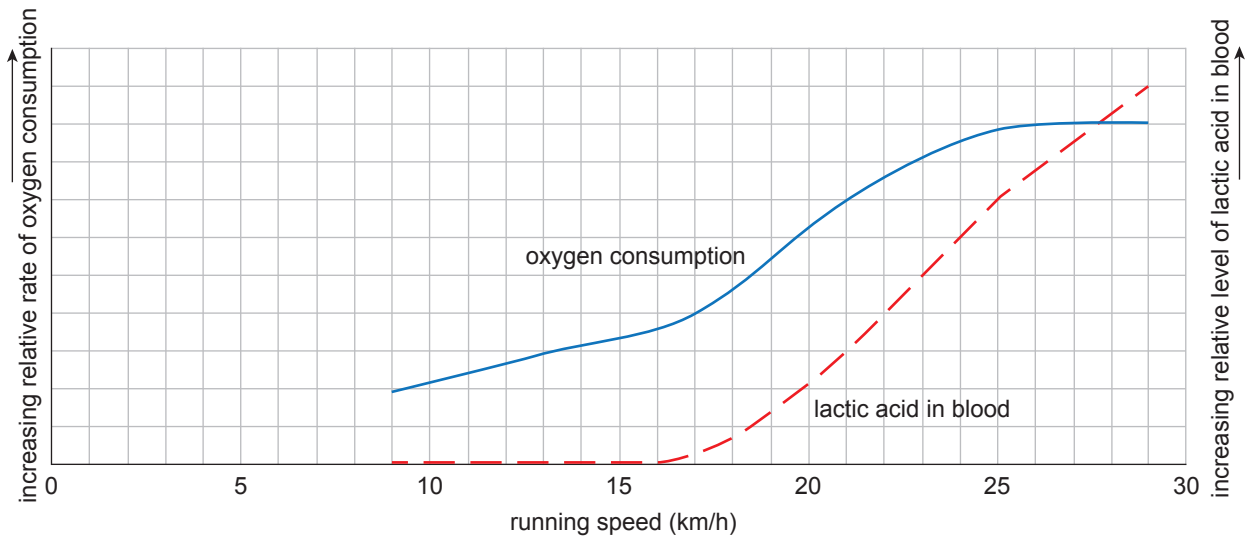
_____ (4 marks)

(c) Ibuprofen is a drug used to treat fever. This drug causes an increase in the diameter of blood vessels, an effect called 'vasodilation'.

Describe how vasodilation can reduce body temperature.

_____ (4 marks)

32. Refer to the following graphs, which show the relationship between the relative rate of oxygen consumption and the relative level of lactic acid in the blood of an athlete exercising at running speeds of between 9 and 29 kilometres per hour:



(a) Using the data from the graphs above, state the range of running speeds during which only aerobic respiration is occurring in the athlete's muscles.

_____ (2 marks)

(b) Compare the amount of energy released by aerobic respiration and fermentation of a molecule of glucose.

 _____ (2 marks)

(c) During their preparation for a race, some athletes consume drinks that contain caffeine. Evidence suggests that caffeine is able to release free fatty acids and reduce the use of muscular glycogen by the body. Some sporting authorities have argued that caffeine should be a banned substance in sport.

State **one** reason for and **one** reason against the banning of caffeine in sport.

Reason for: _____

Reason against: _____

 _____ (4 marks)

33. The ecologist Professor David Bowman from the University of Tasmania has suggested that a population of large herbivores such as African elephants should be introduced to the northern Australian community (as shown in the digitally manipulated image below). He claims that the elephants would eat large areas of grass, such as the introduced African gamba grass, thereby reducing the undergrowth that provides fuel for large fires and food for introduced rabbits.



Source: Adapted from © Photosbyas.../Dreamstime.com and © Kellers/Dreamstime.com

- (a) Explain the difference between the terms 'population' and 'community'.

(4 marks)

- (b) State **one** biotic factor and **one** abiotic factor that may affect a population of elephants in Australia.

Biotic factor: _____

Abiotic factor: _____

(4 marks)

- (c) State the name of the process by which natural selection could result in the formation of a new species from African elephants introduced to Australia.

_____ (2 marks)

- (d) 'The reproductive strategy of African elephants is considered to be more *K*-selected than *r*-selected.'

State two features of a *K*-selected reproductive strategy that are consistent with this statement.

Feature 1: _____

Feature 2: _____

_____ (4 marks)

- (e) *The banteng, a type of wild ox from South-East Asia (shown in the photograph below), was introduced into northern Australia in 1849. The banteng is now endangered in South-East Asia, but is thriving in Australia.*



Source: © Piyaphanta.../Dreamstime.com

Give **one** reason for and **one** reason against using the introduction of endangered species to foreign countries as a way of conserving them.

Reason for: _____

Reason against: _____

_____ (4 marks)

34. Global warming is causing glaciers in many parts of the world to retreat as a result of melting. These glaciers leave behind large areas of broken rock called 'moraines'. The moraine areas are sterile; they have no plant or animal life. Over time plant and animal life becomes established in the areas and eventually results in a stable community known as a 'climax community'.

(a) State the name of the process that over time results in a climax community in these areas.

_____ (2 marks)

(b) For a community to develop in the moraine areas, producers must first be established. The first species to become established on the moraines is a black alga, *Lyngbya wollei*. Describe how the presence of this alga leads to the establishment of other plant species.

_____ (4 marks)



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External Examination 2012

2012 BIOLOGY

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**QUESTION
BOOKLET**

3

8 pages, 2 questions

Monday 5 November: 9 a.m.

Section C

Write your answers to Section C in this question booklet.

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SECTION C: EXTENDED-RESPONSE QUESTIONS (Questions 35 and 36)

(30 marks)

Answer **both** questions in this section.

Write your answers in this question booklet:

- Question 35, on pages 4 and 5, is worth 15 marks.
- Question 36, on pages 6 and 7, is worth 15 marks.

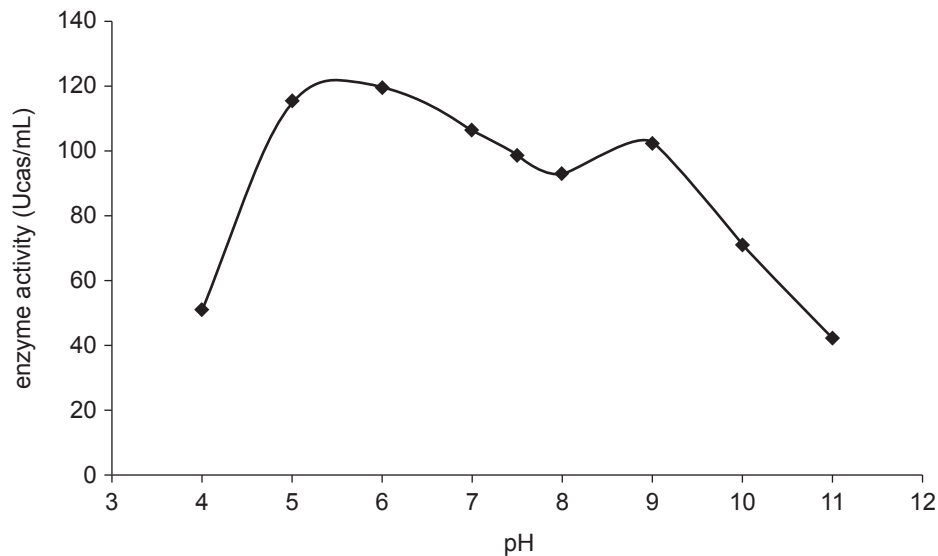
*You should spend about 30 minutes on this section,
5 to 10 minutes planning and 20 to 25 minutes writing.*

*Credit will be given for clear, well-expressed answers that
are well organised and relevant to the questions.*

35. Civet coffee is the most exotic and expensive coffee made. A marsupial called the Asian palm civet (*Paradoxurus hermaphroditus*) eats ripe coffee berries, which pass through its digestive system. The partially digested coffee beans from the berries are egested in the faeces; they are then collected and roasted. The distinctive coffee that is produced does not have the usual bitterness of coffee beans.

An enzyme in the civet's digestive system, called a proteolytic enzyme, breaks down some of the large protein molecules of the coffee beans into smaller peptides and free amino acids. Synthetic civet coffee could be manufactured on an industrial scale by treating coffee beans with this proteolytic enzyme at an optimal pH.

Scientists carried out an investigation to determine the effect of pH on the activity of the civet's proteolytic enzyme. The graph below shows the data collected:



Source: Adapted from D. Vallés, S. Furtado, & A.M.B. Cantera, 'Characterization of news proteolytic enzymes from ripe fruits of *Bromelia antiacantha* Bertol. (Bromeliaceae)' in *Enzyme and Microbial Technology*, vol. 40, no. 3, 5 February 2007, pp. 409–13, reproduced on www.sciencedirect.com

By referring to this investigation:

- explain the importance of having only one independent variable
- describe how the scientists could minimise the effects of random errors
- write a conclusion based on the data in the graph, and state one implication for the industrial production of synthetic civet coffee.

(15 marks)
