



South Australian  
Certificate of Education

# Stage 2 Biology

## Sample Examination Questions

## MULTIPLE-CHOICE QUESTIONS

Each question is worth 1 mark.

1. In eukaryotic cells
- J. exons are removed from mRNA molecules after transcription.
  - K. exons are added to mRNA molecules after transcription.
  - L. introns are removed from mRNA molecules after transcription.
  - M. introns are added to mRNA molecules after transcription.
2. Two DNA samples are each cut using a restriction enzyme before undergoing gel electrophoresis:
- Sample 1 is linear DNA and is cut at four positions
  - Sample 2 is a plasmid and is cut at three positions.

Which one of the following alternatives correctly identifies the number of bands that will be observed after the two samples separately undergo gel electrophoresis?

Number of bands		
	Sample 1	Sample 2
J.	four	three
K.	four	four
L.	five	three
M.	five	four

3. Immunoglobulin E (IgE) binds to receptors on mast cells, triggering symptoms associated with allergic diseases.
- Researchers have found that the symptoms of these diseases can be reduced by administering anti-IgE, which binds to IgE, preventing it from binding to receptors on mast cells.
- Which one of the following statements is consistent with the information above?
- J. Anti-IgE has a three-dimensional shape that is complementary to the shape of the receptors on mast cells.
  - K. Anti-IgE has the same three-dimensional shape as IgE.
  - L. IgE has a three-dimensional shape that is complementary to the shape of the receptors on mast cells.
  - M. IgE has the same three-dimensional shape as the receptors on mast cells.

4. A segment of DNA is made up of strand 1 and strand 2:

- 31% of the bases in strand 1 are adenine
- 12% of the bases in strand 2 are cytosine
- 27% of the bases in strand 2 are guanine.

Which one of the following statements is correct?

- J. Strand 1 contains 30% thymine.
- K. Strand 1 contains 30% guanine.
- L. Strand 2 contains 30% thymine.
- M. Strand 2 contains 31% adenine.

5. Which one of the following statements is correct?

- J. Animal cells contain mitochondria, but plant cells do not.
- K. Both plant cells and animal cells have a cell wall.
- L. Plant cells have a cell wall instead of a cell membrane.
- M. Both plant cells and animal cells may contain vacuoles.

6. Eukaryotic cells do **not**

- J. contain linear chromosomes that attach to the cell membrane during mitosis.
- K. contain organelles that have a single membrane.
- L. exist independently as single cells.
- M. contain circular DNA.

7. During the transformation of energy by heterotrophs

- J. energy is required to produce glucose.
- K. energy is required to break bonds.
- L. glucose is formed, releasing energy.
- M. light energy and chlorophyll are required.

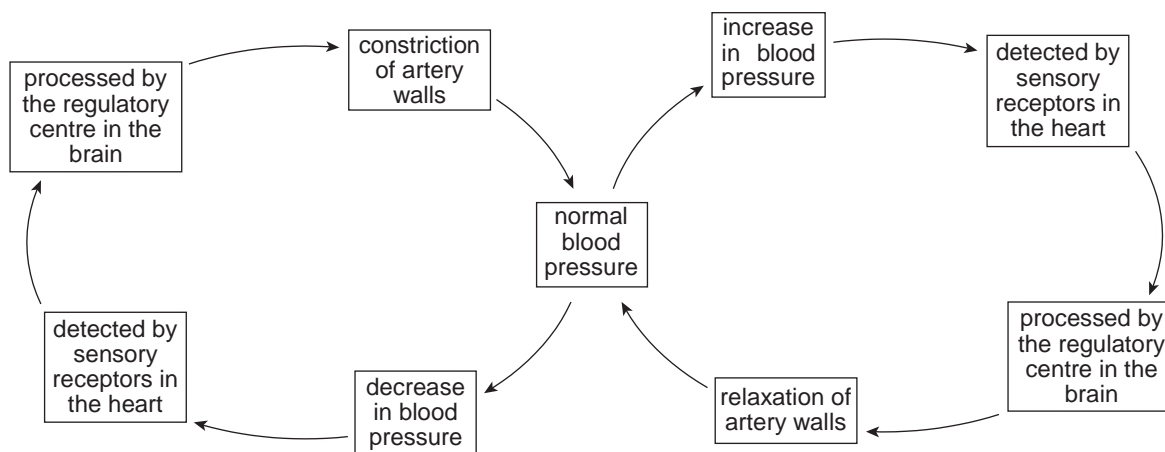
8. Which one of the following combinations correctly identifies the site of synthesis of a hormone that is a protein, the structure in which the hormone is packaged, and the process by which the hormone leaves the cell?

	Site of synthesis of a protein hormone	Structure in which the hormone is packaged	Process by which the hormone leaves the cell
J.	endoplasmic reticulum	Golgi body	facilitated diffusion
K.	ribosome	Golgi body	exocytosis
L.	ribosome	lysosome	facilitated diffusion
M.	endoplasmic reticulum	lysosome	exocytosis

9. Athletes often feel anxious when waiting for the starter's gun to be fired.

In this situation, athletes would experience

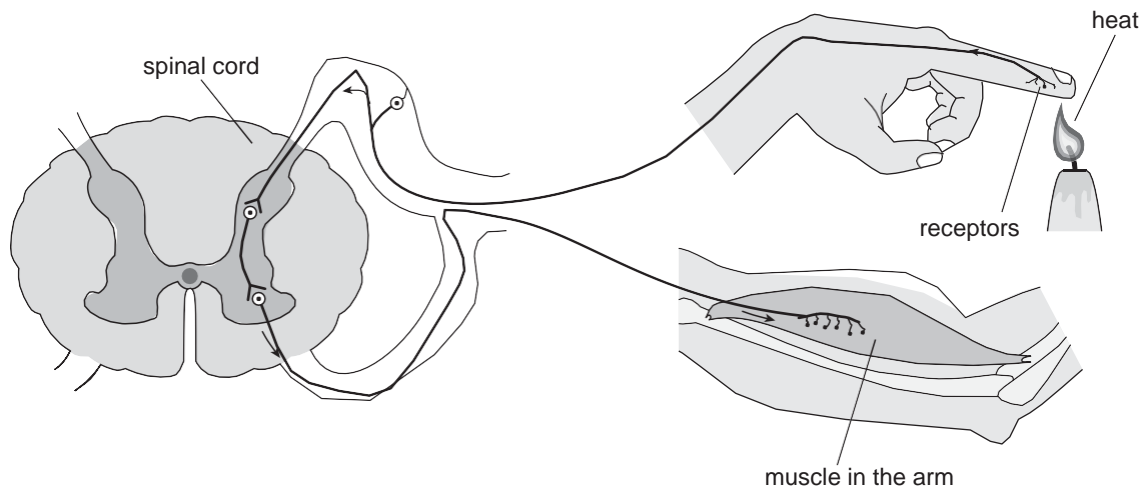
- J. a decrease in their heart rate due to the release of adrenaline.  
 K. an increase in the amount of oxygen available to their muscles due to the release of adrenaline.  
 L. a 'fight or flight' response due to a decrease in the amount of adrenaline in their blood.  
 M. a decrease in urine output due to the direct effect of adrenaline.
10. Refer to the following pathway, which shows the response of the human body to changes in blood pressure:



Which one of the following statements is **not** consistent with the information in the pathway?

- J. The body responds to a decrease in blood pressure.  
 K. This pathway is an example of a reflex response.  
 L. In this pathway, the effectors are the artery walls.  
 M. This pathway involves negative feedback.

11. Refer to the following diagram, which shows a nerve pathway:

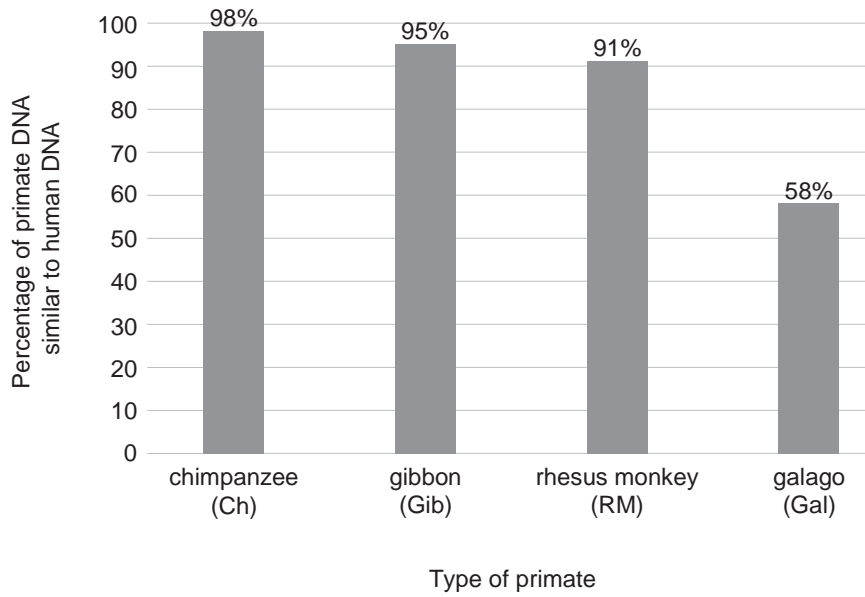


Source: Adapted from danielscienceblog.blogspot.com

If the motor neuron is cut, the most likely outcome is

- J. the heat from the flame is still felt.
  - K. a hormonal message is transmitted instead of an electrical message.
  - L. the speed of transmission is reduced, increasing the reaction time of the response.
  - M. the message is transmitted directly from the sensory neuron to the muscle in the arm.
12. Several diverse species of plants known as 'silverswords' grow in the Hawaiian islands. Although the species have different characteristics, they have evolved from one common ancestor.
- Which one of the following terms describes the evolution of diverse species from a common ancestor?
- J. Convergent evolution.
  - K. Natural selection.
  - L. Adaptive radiation.
  - M. Ecological succession.
13. Which one of the following statements describes crossing over?
- J. Sister chromatids exchange DNA.
  - K. DNA is exchanged between chromosomes that are not homologous.
  - L. Genes are exchanged between chromatids of the same chromosome.
  - M. Genes are exchanged between homologous chromosomes.

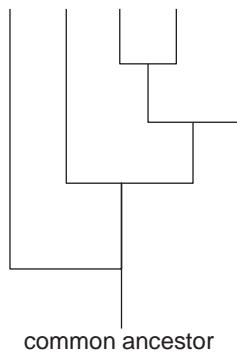
14. Refer to the following graph, which shows the percentage of similarity for four types of primate DNA compared with human DNA:



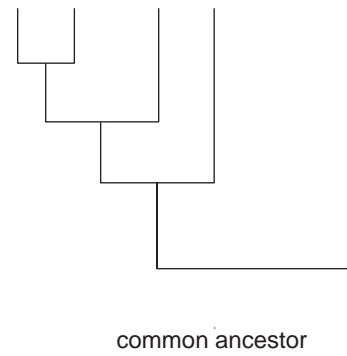
Source: Adapted from Mills, P 2015, 'Comparison of primate DNA', 'Macromolecule evolution' SlideShare, LinkedIn Education, 13 May, slide 28, viewed 13 November 2018, www.slideshare.net

Which one of the following phylogenetic tree diagrams is consistent with the information in the graph above?

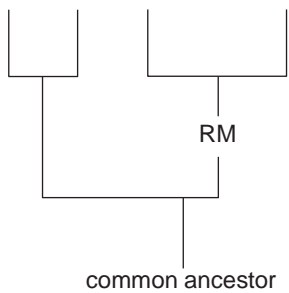
J. Gal RM Ch Hu Gib



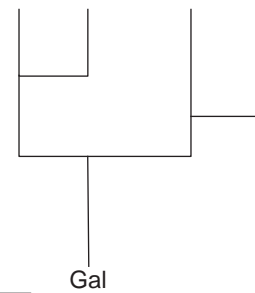
K. Hu Gal RM Gib Ch



L. Hu Ch Gib Gal



M. Gib RM Ch Hu



Hu = human being

15. A group of biology students designed an investigation to determine which brand of fertiliser would result in the largest crop yield from their school's farmland.

Which one of the following statements is correct?

- J. The independent variable of this investigation is crop yield.
- K. Factors that should be kept constant include: type of crop, brand of fertiliser, and volume of water provided.
- L. Factors that cannot be controlled include: the amount of fertiliser used, the amount of rain, the contents of the soil, and the number of seeds used.
- M. Any conclusion drawn from the results of this investigation would most likely be limited to the school's farmland.

## FREE RESPONSE QUESTIONS

16. In January 2018, Hans Jonatan became the first human being to have the sequence of his genome determined using only the DNA of living descendants.

Hans was born in 1784 to an African mother and a European father. He died in Iceland in 1827. DNA from 182 of Hans's descendants was sequenced.

(a) Usually the polymerase chain reaction (PCR) is used before DNA is sequenced.

(i) State the purpose of cooling DNA during the PCR.

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\_\_\_\_\_ (1 mark)

(ii) Explain why *human* polymerase enzymes cannot be used in the PCR.

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\_\_\_\_\_ (3 marks)

(b) Electrophoresis is used to sequence human DNA.

Explain why the banding pattern produced by electrophoresis is unique to each person.

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\_\_\_\_\_ (3 marks)

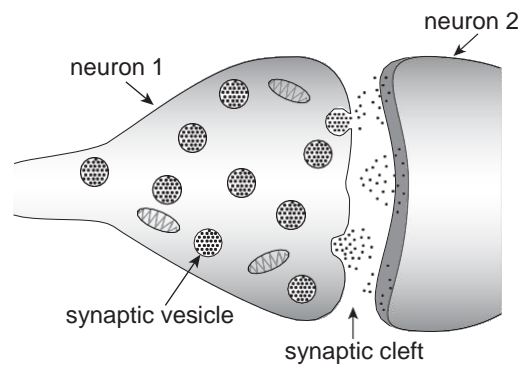
(c) The sequence of Hans Jonatan's genome could be determined because Iceland has a comprehensive genetic database.

Discuss *one* ethical issue related to the large-scale collection of genetic information.

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\_\_\_\_\_  
\_\_\_\_\_ (2 marks)



17. (a) Refer to the following diagram, which shows a synapse between two neurons:



Name the type of chemical, secreted by neurons, that transmits a signal across the synaptic cleft.

\_\_\_\_\_ (1 mark)

Synaptophysin is a protein that is involved in transmitting signals between neurons in the brain.

(b) Describe the role of ribosomal RNA in making synaptophysin.

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\_\_\_\_\_ (2 marks)

(c) In human beings, synaptophysin is encoded by the *SYP* gene. Mutations in the *SYP* gene are associated with altered brain function.

(i) Explain why not all mutations in the *SYP* gene lead to a change in the amino acid sequence of synaptophysin.

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\_\_\_\_\_ (2 marks)

(ii) Explain how a mutation in the *SYP* gene could alter brain function.

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(3 marks)

Refer to the following table, which shows the sequence of amino acids (*asp*, *gln*, *gly*, *pro*, and *tyr*) in the corresponding section of synaptophysin in three different species:

Species	Position of amino acid in sequence									
	291	292	293	294	295	296	297	298	299	300
Human being ( <i>Homo sapiens</i> )	pro	gln	gly	asp	tyr	gly	gln	gln	gly	tyr
Rhesus macaque ( <i>Macaca mulatta</i> )	pro	gln	gly	asp	tyr	gly	gln	gln	gly	tyr
House mouse ( <i>Mus musculus</i> )	gly	pro	gln	gly	asp	tyr	gly	gln	gln	gly

(d) Using data from the table, explain why it is likely that a human being is more closely related to a rhesus macaque than to a house mouse.

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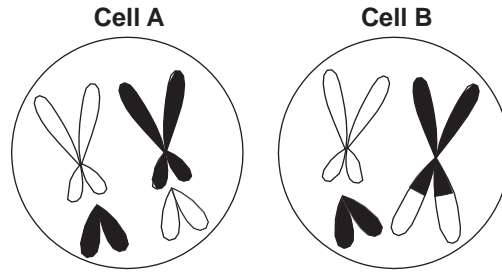
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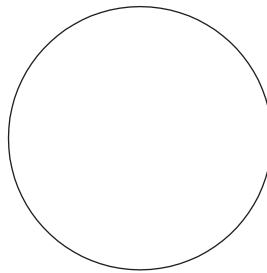
(4 marks)

18. A Robertsonian translocation is a rare event in which two chromosomes join and act as one.

In the diagram below, **Cell A** shows two pairs of chromosomes in a normal diploid cell, and **Cell B** shows the arrangement of these chromosomes after a Robertsonian translocation.



- (a) Draw *one* combination of chromosomes that could occur in a gamete produced by the meiotic division of **Cell A**. Ignore the effects of crossing over.



(2 marks)

- (b) The diploid number of chromosomes in human beings is 46.

Suppose a Robertsonian translocation occurs immediately after the fertilisation of a human egg cell, which gives rise to a new individual.

- (i) State the number of chromosomes in each of the new individual's somatic cells.

\_\_\_\_\_ (1 mark)

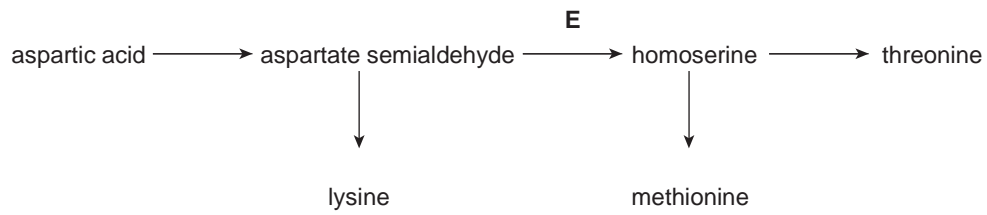
- (ii) Explain why the phenotype of this new individual may be unaffected by the Robertsonian translocation.

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 \_\_\_\_\_ (2 marks)

- (iii) Explain why the new individual may not be able to produce gametes.

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 \_\_\_\_\_ (2 marks)

19. (a) Refer to the following diagram, which shows some of the steps in a metabolic pathway. The step from aspartate semialdehyde to homoserine is catalysed by the enzyme **E**:



State *one* effect on this pathway of adding a chemical inhibitor of the enzyme **E**.

\_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(b) Explain why a different enzyme is required at each step of a metabolic pathway.

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\_\_\_\_\_ (2 marks)

(c) State *two* reasons *why* metabolic pathways have many regulated steps.

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\_\_\_\_\_ (2 marks)

20. (a) The protein p53 prevents cells from reproducing too rapidly. It is produced in a cell when damaged DNA is detected during the G<sub>1</sub> phase of the cell cycle.

The presence of p53 interrupts the cell cycle.

- (i) Explain why it is important that the cell cycle is interrupted prior to the S phase if the concentration of p53 is high.

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- (ii) Explain **how** a change in the gene that codes for p53 could result in a cell becoming cancerous.

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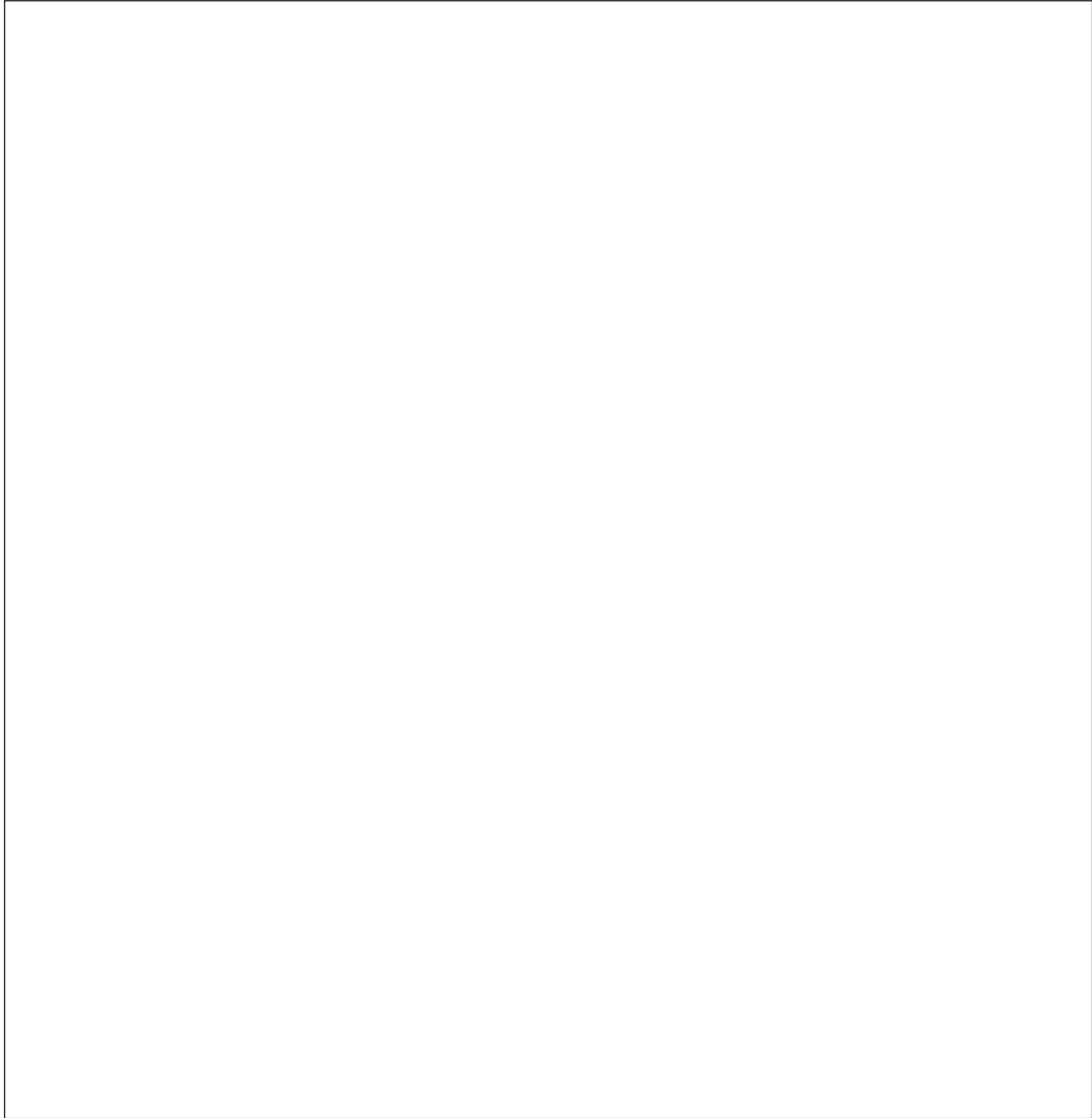
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\_\_\_\_\_ (3 marks)

Human growth hormone (HGH) is an example of an external factor that is added to the growth medium when human cells are cultured.

(b) Draw a labelled diagram, illustrating the different components of the cell membrane.

On your diagram, show how a peptide hormone such as HGH interacts with the cell membrane.

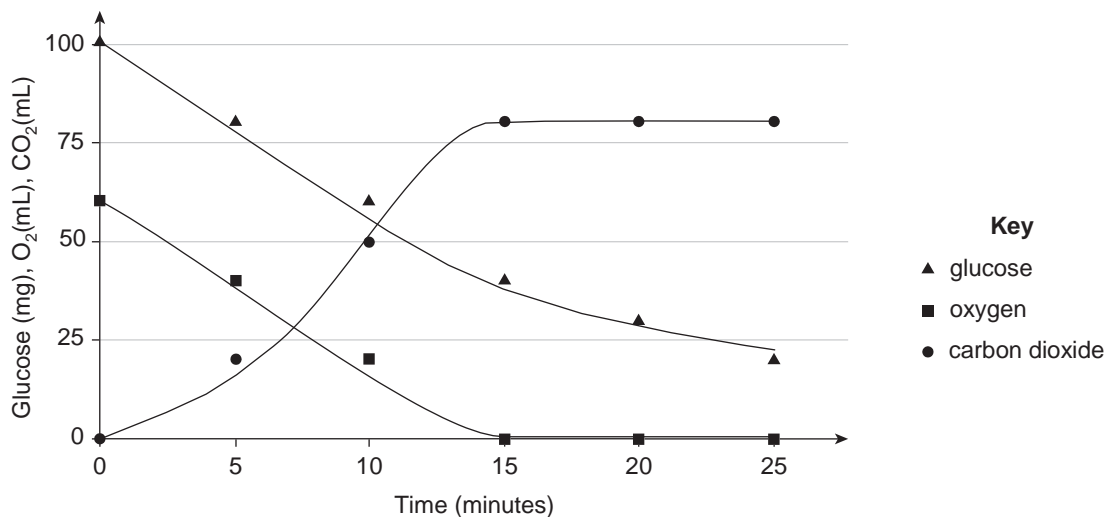


(4 marks)

21. In an investigation, a sample of cells was placed in a container and supplied with oxygen and glucose; the container was then sealed and kept in the dark. Every 5 minutes over a 25-minute period, the following measurements were made:

- the mass of glucose
- the volume of oxygen (O<sub>2</sub>)
- the volume of carbon dioxide (CO<sub>2</sub>).

Refer to the following graph, which shows the results of this investigation:



(a) Write a balanced chemical equation for the energy-releasing metabolic process that occurred within these cells between 0 and 10 minutes.

\_\_\_\_\_ (2 marks)

(b) Explain why the amount of energy released by the cells between 0 and 5 minutes is greater than the amount of energy released by the cells between 15 and 20 minutes.

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 \_\_\_\_\_ (2 marks)

(c) Explain the evidence that indicates that the cells used in this investigation were **not** plant cells.

\_\_\_\_\_  
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 \_\_\_\_\_ (2 marks)





23. In the human body, most cells have a low tolerance to changes in pH. The optimal pH range is 7.35 to 7.45.

(a) Explain why pH must be maintained within this narrow range for most human cells.

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(2 marks)

(b) Explain how the brain monitors blood pH in order to maintain a constant level of carbon dioxide in the blood.

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(4 marks)

(c) Hormones are involved in homeostasis. Describe how hormones that are produced in the brain are able to affect many organs in the body.

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(2 marks)

It has been suggested that maintaining blood pH at 7.4 has health benefits.

- (d) Explain *two* factors that would need to be considered when designing an investigation into the effect of blood pH on the health of human beings.

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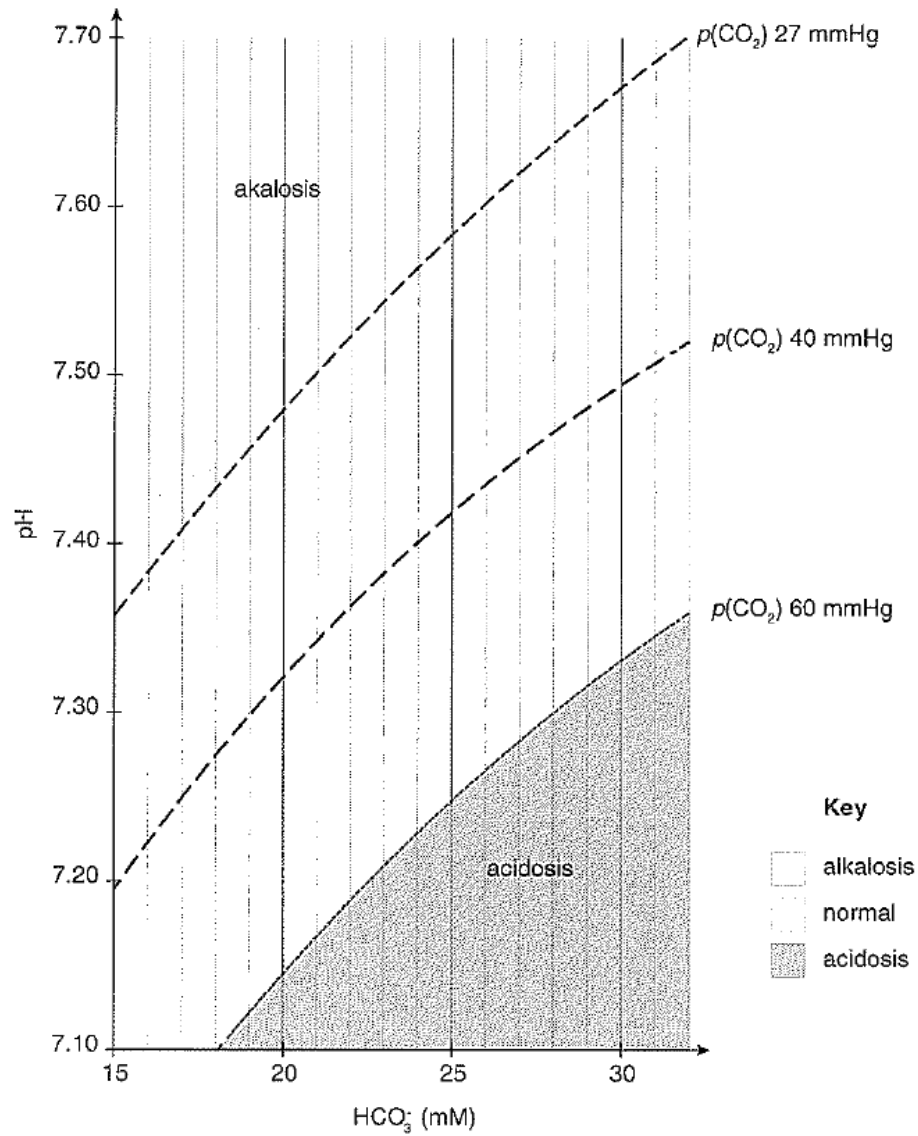
(4 marks)

***Question 23 continues on the next page.***

Question 23 continued

The following graphs show the relationship between the concentration of hydrogen carbonate ( $\text{HCO}_3^-$ ) in the blood and blood pH at three different partial pressures of dissolved carbon dioxide [ $p(\text{CO}_2)$ ].

The graphs indicate the conditions under which the respiratory diseases acidosis and alkalosis occur in human beings.



Source: Based on Wikipedia contributors 2015, 'Davenport\_Fig\_11.jpg', Wikimedia commons, the free media repository, 23 August, viewed 13 November 2018, commons.wikimedia.org, CC BY-SA 3.0

Refer to the information on the previous page when answering questions (e) to (h).

- (e) State the blood pH of a person with 30 mM  $\text{HCO}_3^-$  at a  $p(\text{CO}_2)$  of 60 mmHg.

\_\_\_\_\_ (1 mark)

- (f) State what is likely to happen to blood pH as  $p(\text{CO}_2)$  decreases.

\_\_\_\_\_ (1 mark)

- (g) Using the data from the graph, state the values of  $\text{HCO}_3^-$  concentration and  $p(\text{CO}_2)$  at which an individual will experience acidosis.

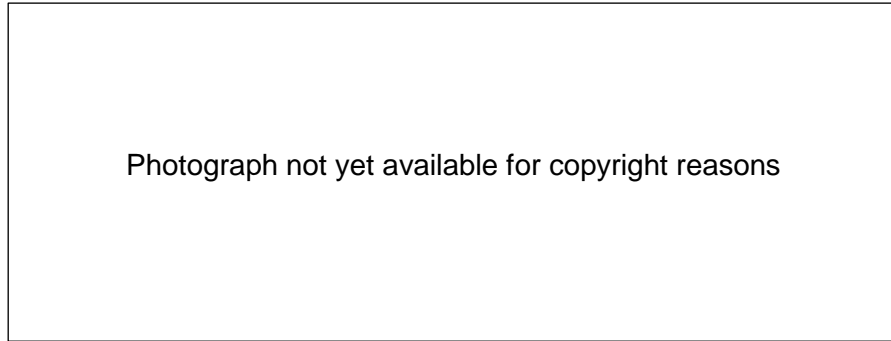
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\_\_\_\_\_ (2 marks)

- (h) Explain *one* limitation of any conclusions drawn from these graphs.

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\_\_\_\_\_ (2 marks)



- (b) Two fruit fly species, *Drosophila persimilis* and *Drosophila pseudoobscura*, are very similar in appearance. However, *D. persimilis* is generally active in the early morning, while *D. pseudoobscura* is active in the afternoon. Both species reproduce sexually.



Explain why *D. persimilis* and *D. pseudoobscura* are considered to be different species.

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(3 marks)

- (c) Choose *one post-zygotic* mechanism and explain how it maintains distinct species.

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(2 marks)

25. In 1991 a small area of vegetation in Victoria, Australia, was destroyed by a fire. Before the fire, the plants growing in this area were dominated by one species, the native coastal tea-tree *Leptospermum laevigatum*. There were between 1 and 3 different plant species per square metre. A few weeks after the fire, this area had between 15 and 20 different plant species per square metre.

- (a) (i) Identify the process that leads to changes over time in the mix of plant species growing in an area after an event such as a fire.

\_\_\_\_\_ (1 mark)

- (ii) Describe the process that leads to changes over time in the mix of plant species present after an event such as a fire.

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\_\_\_\_\_ (3 marks)

- (b) Discuss *one* long-term biological consequence of **not** maintaining biodiversity.

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\_\_\_\_\_ (3 marks)

26. In 1967, a biologist named Lynn Margulis put forward evidence of an evolutionary link between bacterial cells and eukaryotic cells. Her idea was controversial at the time, but subsequent research has supported it.

(a) Name *one* structure that is common to all prokaryotic and eukaryotic cells.

\_\_\_\_\_ (1 mark)

(b) Describe *one* piece of evidence that suggests that prokaryotic cells existed before eukaryotic cells.

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\_\_\_\_\_ (2 marks)

(c) Describe *two* pieces of evidence that link the evolution of eukaryotic cells to bacterial cells.

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\_\_\_\_\_ (4 marks)



