



# Biology

## November 2018 sample paper

### Question Booklet 1

- **Section 1: Multiple-choice Questions** (Questions 1 to 15) 15 marks
- Answer **all** questions in Section 1
- Write your answers on the blue multiple-choice answer sheet
- Allow approximately 20 minutes
- **Part A of Section 2** (Questions 16 to 21) 53 marks
- Answer **all** questions in Part A
- Write your answers in this question booklet
- You may write on page 18 if you need more space
- Allow approximately 50 minutes

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### Examination information

#### Materials

- Question Booklet 1 (Section 1 and Part A of Section 2)
- Question Booklet 2 (Part B of Section 2)
- Multiple-choice answer sheet (blue)
- SACE registration number label

#### Reading time

- 10 minutes

#### Writing time

- 2 hours
- Clear, well-expressed answers are required
- Use black or blue pen
- Approved calculators may be used

**Total marks 120**

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Attach your SACE registration number label here

#### For office use only

Supervisor check	Re-marked

## SECTION 1: MULTIPLE-CHOICE QUESTIONS (Questions 1 to 15)

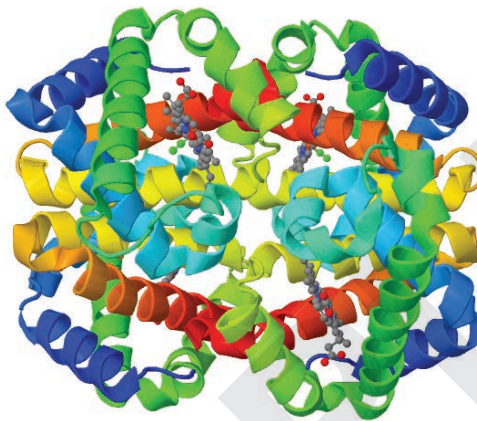
(15 marks)

Answer **all** questions in this section.

Each of the 15 multiple-choice questions in Section 1 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 blue multiple-choice answer sheet. Use black or blue pen.

Each question is worth 1 mark; marks are not deducted for incorrect answers.

1. Refer to the following diagram, which shows a molecule of foetal haemoglobin (HbF) consisting of two alpha and two gamma polypeptide chains:



Source: A. Herraéz 2016, 'Fetal hemoglobin', rendered using Jmol from 4MQJ at PDB, <https://commons.wikimedia.org/w/index.php?curid=18062550>

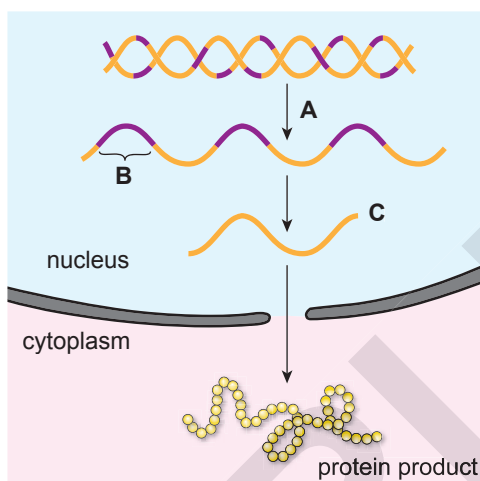
Using only the diagram, it is **not** possible to determine the

- J. primary structure of HbF.
- K. secondary structure of HbF.
- L. tertiary structure of HbF.
- M. quaternary structure of HbF.

2. Monozygotic twins develop when a single fertilised egg splits in two and two embryos are formed. These twins exhibit differences in phenotype for the expression of syndromes such as Fragile X because they are

- J. genetically identical but epigenetically different.
- K. genetically and epigenetically identical.
- L. genetically different and epigenetically identical.
- M. genetically and epigenetically different.

3. Refer to the following diagram, which shows the process of protein synthesis:

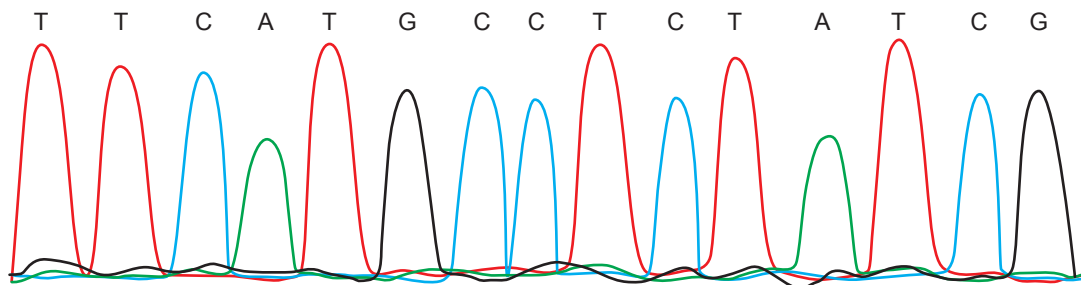


Which one of the following combinations of process **A**, segment **B**, and molecule **C** is correct?

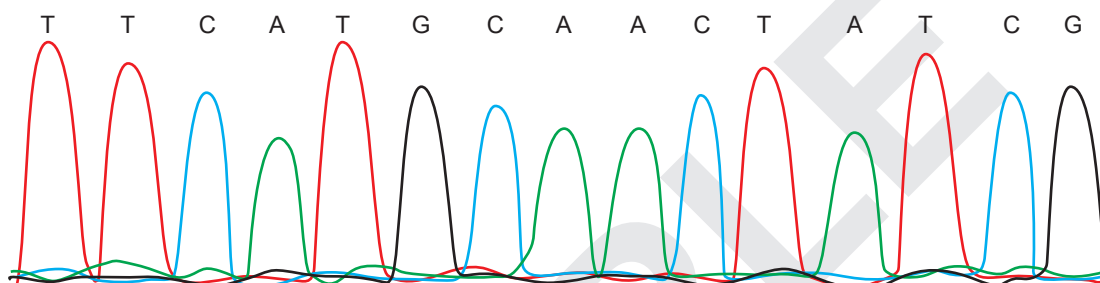
	<i>Process A</i>	<i>Segment B</i>	<i>Molecule C</i>
J.	translation	intron	DNA
K.	transcription	intron	RNA
L.	translation	exon	DNA
M.	transcription	exon	RNA

4. Refer to the following diagram, which shows two electropherograms of a segment of a gene that codes for a particular protein. Sequence A shows the nucleotide sequence for five amino acids in a person who has a normal gene. Sequence B is the same sequence in a person who has a mutated gene.

**Sequence A**



**Sequence B**



The table below shows selected DNA codons and their corresponding amino acids.

<i>DNA codon</i>	<i>Amino acid</i>
ATG	methionine
CAA	glutamine
CCT	proline
CTA	leucine
TCG	serine
TTC	phenylalanine

Using the information in the two electropherograms and the table, you can tell that the mutation shown

- J. may result in a change in one amino acid in the protein.
- K. will result in a change in one amino acid in the protein.
- L. may result in a change in two amino acids in the protein.
- M. will result in a change in two amino acids in the protein.

5. Which one of the following combinations matches a cell organelle with its function and one of its structural features?

	<i>Organelle</i>	<i>Function</i>	<i>Structural feature</i>
J.	nucleolus	controls cell activities	membrane pores
K.	lysosome	intracellular digestion	single membrane
L.	ribosome	amino acid synthesis	no membrane
M.	mitochondrion	photosynthesis	double membrane

6. Which one of the following processes occurs in the normal division of somatic cells but **not** in the production of gametes from germ-line cells?

- J. The production of diploid daughter cells.
- K. The pairing of homologous chromosomes.
- L. The separation of chromatids.
- M. The exchange of genetic material.

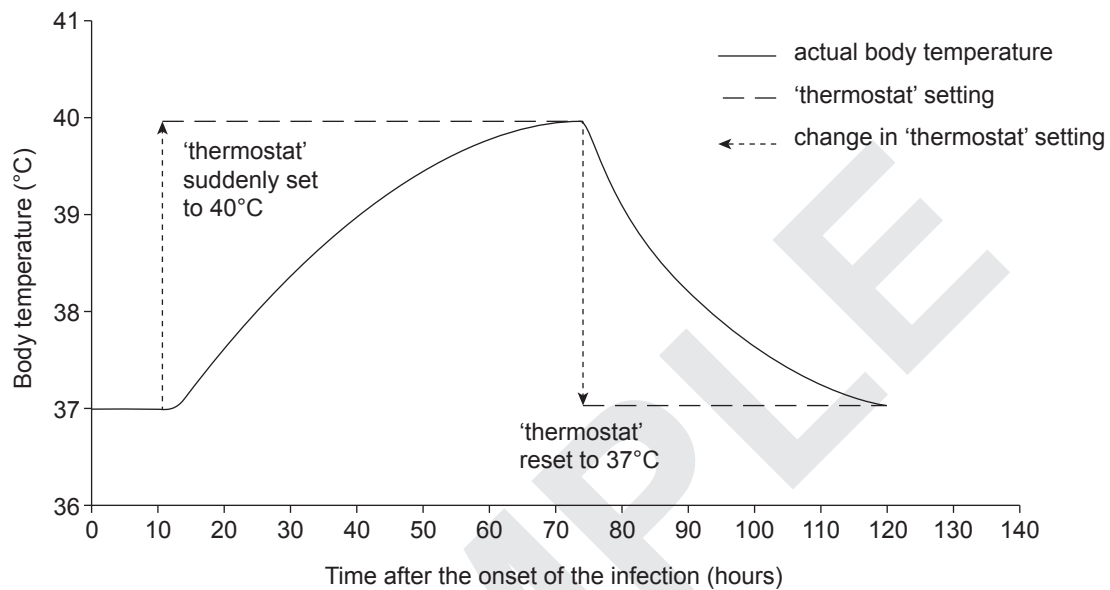
7. Which one of the following combinations correctly matches a type of movement with the substances moved, the need for a membrane, the need for energy, and the direction of movement?

	<i>Type of movement</i>	<i>Substances moved</i>	<i>Need for a membrane</i>	<i>Need for energy</i>	<i>Direction of movement</i>
J.	facilitated diffusion	ions, amino acids, sugars	yes	yes	with the concentration gradient
K.	simple diffusion	gases, solutes	no	no	with the concentration gradient
L.	osmosis	water, solutes	yes	no	against the concentration gradient
M.	active transport	ions, amino acids, sugars	no	yes	against the concentration gradient

8. Which one of the following statements is **not** correct?

- J. Neurotransmitters are released by neurons.
- K. Neurotransmitters carry a message from one neuron to an adjacent neuron.
- L. Neurotransmitters detect a stimulus.
- M. Neurotransmitters bind to specific receptors.

9. The response to an increase in the level of antidiuretic hormone in the blood of a healthy human being would include
- J. increased urine output.
  - K. decreased production of insulin.
  - L. decreased blood pressure.
  - M. increased water reabsorption.
10. Refer to the following graph, which shows the changes in the body temperature of a human being during the first 120 hours after the onset of a bacterial infection:



During a bacterial infection, white blood cells release a protein that changes the set point of the brain 'thermostat' from 37°C to 40°C. When this protein breaks down after about 3 days, the brain 'thermostat' is reset to 37°C.

Which one of the following responses is most likely to occur?

- J. A decrease in thyroxine production between 10 and 70 hours after the onset of the infection.
- K. A decrease in metabolic activity between 10 and 70 hours after the onset of the infection.
- L. Shivering at 40 hours after the onset of the infection, when the body temperature is about 39°C.
- M. A decrease in sweating at 80 hours after the onset of the infection, when the body temperature is about 39°C.

11. Which one of the following statements about the regulation of secretion of the hormones insulin and glucagon from the pancreas is **false**?
- J. Some cells in the pancreas respond to changes in the blood glucose level.
  - K. In glucose homeostasis, the blood hormone levels are regulated by negative feedback loops.
  - L. Sensory receptors and effectors in the glucose control pathway are located in the pancreas.
  - M. After a meal, the increase in the blood glucose level stimulates the release of glucagon.
12. At its closest point, Kangaroo Island lies about 13.5 km off the coast of South Australia. It is estimated that the population of echidnas (spiny anteaters) on this island has been geographically separated from mainland populations of echidnas for around 18 000 years.

**Kangaroo Island echidna**  
***Tachyglossus aculeatus multiaculeatus***



Source: © Anthony Sheffield | Dreamstime.com

The **individuals** in a population of organisms that becomes geographically isolated from all other populations of its species, such as the Kangaroo Island echidnas, will

- J. gradually undergo allopatric speciation and evolve into a new species.
- K. become genetically very similar to each other as a result of genetic drift.
- L. adapt to their environment, possibly changing into a new species.
- M. be subjected to selection pressures in their isolated environment.

13. In rare circumstances, a male false killer whale (*Pseudorca crassidens*) breeds with a female common bottlenose dolphin (*Tursiops truncatus*) and produces live offspring called 'wholphins'.

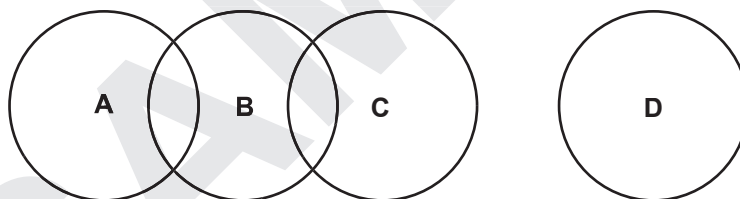
#### Wholphin



Source: © beaverboy56 | shutterstock.com

For a biologist to conclude that the false killer whale and the common bottlenose dolphin are the same species, the resulting offspring would need to

- J. be physically similar to both parent organisms.
  - K. be unable to produce gametes.
  - L. be able to produce offspring with another false killer whale or common bottlenose dolphin.
  - M. inherit half of their chromosomes from the common bottlenose dolphin.
14. Refer to the following diagram, which shows four populations of frogs (**A**, **B**, **C**, and **D**). These populations are represented by circles. The circles that overlap indicate interbreeding populations. The circles that do not overlap indicate populations that cannot interbreed to produce fertile offspring.



From this diagram, it would be reasonable to conclude that

- J. population **D** will evolve into a new species.
- K. populations **A** and **C** have the same predators.
- L. three different species would remain if population **C** died out.
- M. two different species are represented by populations **A**, **B**, **C**, and **D**.



15. Two students, Student **A** and Student **B**, investigated anaerobic respiration by taking measurements of the volume of carbon dioxide (CO<sub>2</sub>) produced by yeast during bread-making. Both students used the same experimental conditions when collecting the data recorded in the table below.

Sample number	Volume of CO <sub>2</sub> produced (arbitrary units)	
	Student <b>A</b>	Student <b>B</b>
1	1.02	1.01
2	1.10	1.02
3	1.15	1.02
4	0.99	1.03
5	1.09	1.02
<b>Average</b>	<b>1.07</b>	<b>1.02</b>

If the true value for this experiment was 1.05 (arbitrary units), the data in the table indicate that the set of data collected by Student **A**

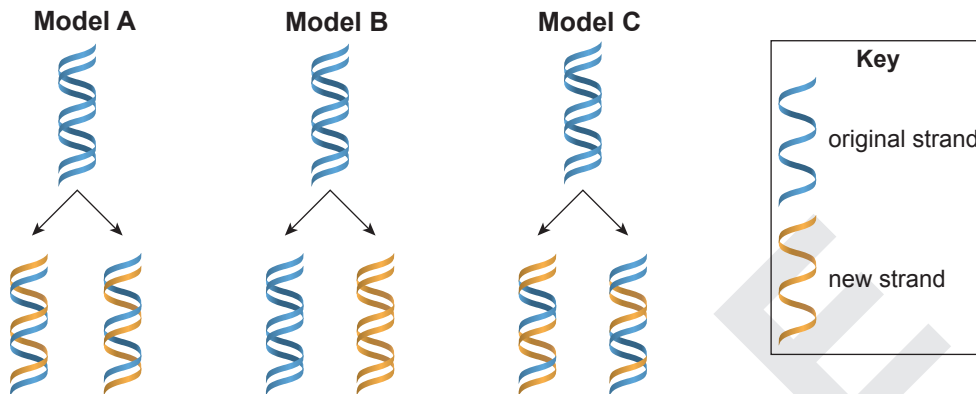
- J. has the same random errors as the set of data collected by Student **B**.
- K. has random errors, but the set of data collected by Student **B** does not.
- L. is more accurate than the set of data collected by Student **B**.
- M. is more reliable than the set of data collected by Student **B**.

**SECTION 2: Part A** (Questions 16 to 21)

(53 marks)

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

16. Refer to the following diagram, which shows three different models of DNA replication (**A**, **B**, and **C**). The blue strands are the original DNA from a parent cell and the yellow strands are the newly synthesised DNA.



- (a) Write the letter of the model that represents DNA replication in eukaryotes.

(1 mark)

- (b) Describe DNA replication in eukaryotes with reference to the original DNA strands and the newly synthesised DNA strands.

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(4 marks)

(c) State *one* environmental factor that could change the base sequence of DNA.

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(1 mark)

(d) Explain the difference between the potential consequences of mutations in germ cells and the potential consequences of mutations in somatic cells.

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(4 marks)

SAMPLE

17. Progeria is a syndrome that results in premature ageing.



Source: P. Scaffidi, L. Gordon, & T. Mistelli 2005, 'The cell nucleus and aging: tantalizing clues and hopeful promises' *PLoS Biology* 3(11): e395. doi:10.1371/journal.pbio.0030395

The syndrome arises from a single point mutation in the gene LMNA. The resulting abnormal protein is called 'progerin' and it weakens the nuclear membrane.

Without the normal form of the protein coded for by the LMNA gene, the ability of the cell to divide is limited.

The following table compares the steps that occur in a normal cell with the steps that occur in a cell affected by progeria.

<i>Steps in normal cell</i>	<i>Steps in cell affected by progeria</i>
The gene LMNA codes for a protein called prelamin A	
Farnesyl group attaches to the end of prelamin A	
Farnesyl group is <i>removed</i> from prelamin A	Farnesyl group remains <i>attached</i> to prelamin A
Normal form of prelamin A is called 'lamin A'	Abnormal form of prelamin A is call 'progerin'
Lamin A is not anchored to the nuclear rim	Progerin is anchored to the nuclear rim
Normal shape of the nucleus	Abnormally shaped nucleus

Source: Adapted from Wikipedia 2017, 'Progeria', viewed 17 March, 2017, <https://en.wikipedia.org/wiki/Progeria>, text is available under the Creative Commons Attribution - ShareALike License

- (a) One treatment for progeria is doses of an anticancer drug that inhibits the attachment of the farnesyl group to prelamin A.

Using the information in the table, explain how preventing attachment of the farnesyl group could improve the functioning of the cells of a person who has progeria.

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(3 marks)

(b) Another treatment for progeria uses biotechnology.

Describe how the CRISPR technique could be used to treat people who have progeria.

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(3 marks)

(c) State which treatment you think would be of most benefit to sufferers of progeria — anticancer drug or CRISPR technique. Justify your answer.

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(3 marks)

SAMPLE

18. Cell metabolism is critical to the survival of cells. In eukaryotic cells, biochemical processes in the cell are controlled — in part — by the nature and arrangement of internal membranes.

(a) Describe the structure of the cell membrane according to the fluid mosaic model.

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(3 marks)

(b) Describe the role of the cell membrane in facilitated diffusion.

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(2 marks)

(c) Use an example to explain one role of internal membranes in a eukaryotic cell.

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(3 marks)



20. Scientists studied a group of saltbush plants of the genus *Atriplex*. They measured the amount of CO<sub>2</sub> used by saltbush leaves (CO<sub>2</sub> use) and compared this with the amount of CO<sub>2</sub> produced by saltbush leaves (CO<sub>2</sub> production). The scientists compared this ratio of CO<sub>2</sub> use to CO<sub>2</sub> production (U<sub>CO<sub>2</sub></sub>:P<sub>CO<sub>2</sub></sub>) in saltbush leaves of different ages to see if it changed as the leaves grew older. Twenty leaves of each age were tested in this experiment.

(a) Write the chemical equation for the process that takes place in plants and uses CO<sub>2</sub>.

(2 marks)

(b) State two factors that should be held constant in the experiment described above.

(i) Factor 1: \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(ii) Factor 2: \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(c) Explain why the scientists tested 20 leaves of each age.

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

(d) Explain the significance for the growth of the saltbush plants if the ratio U<sub>CO<sub>2</sub></sub>:P<sub>CO<sub>2</sub></sub> has a value greater than 1:1.

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



21. Refer to the following information:

The Census of Marine Life (CoML), which concluded in 2010, involved scientists in more than 80 countries, including Australia, researching the diversity, distribution, and abundance of life in the oceans over a 10-year period.

The CoML identified thousands of potentially new species, and recorded many known species in new locations.

Many projects have flowed from the CoML.

For example, the Australian Government established the National Environmental Science Programme (NESP). The NESP will assist decision-makers to understand, manage, and conserve Australia's environment by funding world-class biodiversity science and climate science.

The NESP funds six thematic research hubs. One of these is the Marine Biodiversity Hub, which is hosted by the University of Tasmania and administered by the Australian Government Department of the Environment and Energy.

Source: Based on Department of the Environment and Energy, 'National Environmental Science Programme research scope', viewed 23 February 2017, <https://www.environment.gov.au/science/nesp/about>

Discuss how this example illustrates one or more of the key concepts of science as a human endeavour.

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\_\_\_\_\_ (6 marks)





