HERITAGE COLLEGE
A CHRISTADELPHIAN SCHOOL
ADELAIDE, AUSTRALIA

Biology Mid-Year Trial Exam

Question booklet 1

- **Section 1: Multiple choice questions** (Questions 1-15) 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) 49 marks
- Answer ***all*** questions in Part A
- Write your answers in this question booklet
- You may write on final lined page (p. 15) if you need more space
- Allow approximately 50 minutes

Examination Information

Materials

- Question booklet 1 (Section 1 and Part of Section 2)
- Question booklet 2 (Part B of Section 2)
- Multiple-choice answer sheet (blue)

Reading time

- 10 minutes
- Use black or blue pen
- You may use a sharp dark pencil for diagrams and representations
- Approved calculators may be used

Total Marks 114

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

*Answer **all** questions in this section.*

*Each of the 15 multiple-choice questions involves choosing from four alternative answers. 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.

1. Which one of the following cellular processes involves the pairing of the bases cytosine, thymine, and adenine (C, T, and A) with the bases guanine, adenine, and uracil (G, A, and U) respectively?

   J. The replication of DNA.

   K. Translation.

   L. Transcription.

   M. The bonding of amino acids.

2. In human beings glucagon is a hormone produced by the pancreas. Glucagon causes liver cells to convert glycogen to glucose. Glucagon does not affect brain cells.

   It is reasonable to conclude that glucagon

   J. can be transmitted to liver cells but not to brain cells.

   K. is a store of energy in human liver cells but not brain cells.

   L. is formed in response to high levels of blood glucose.

   M. receptors are found on liver cells but not on brain cells.

3. *Nitella* is an alga that lives in fresh water. The concentration of potassium ions is much greater in the cells of *Nitella* than in the surrounding water.

   The movement of potassium ions from the water into the cells of *Nitella* occurs by

   J. osmosis.

   K. exocytosis.

   L. diffusion.

   M. active transport.

4. Refer to the following, which shows the surface area to volume ratio of a spherical cell at two stages of growth.

Stage of growth	Surface area to volume ratio
W	3:1
X	1:1

At stage **W** of its growth, the cell

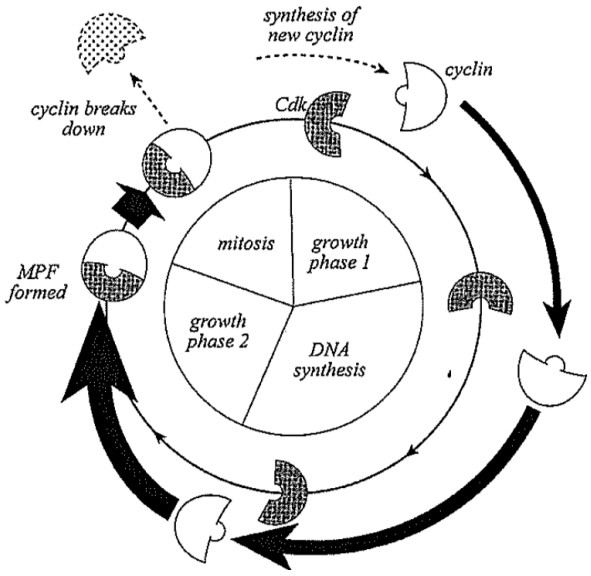
J. has a smaller mass than at stage **X**.

K. is less efficient in exchanging materials by diffusion than at stage **X**.

L. has a larger surface area than at stage **X**.

M. has a larger volume than at stage **X**.

5. Refer to the following diagram, which shows the interaction of two gene products, cyclin and Cdk, during the cell cycle. The thickness of the arrowhead lines indicates the concentration of both Cdk and cyclin in a cell.



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

J. Cyclin and Cdk are both maintained at a constant concentration in the cell.

K. Synthesis of new cyclin begins in growth phase 2.

L. An increase in the concentration of MPF is necessary for DNA synthesis to start.

M. A decrease in the concentration of MPF is necessary for mitosis to be completed.

6. Refer to the following data table that shows the results of an experiment in which Student 1 and Student 2 measured the mass of an object four times. Independent tests had established the actual mass of the object to be 8.600g.

   Student 1 used an electronic balance that weighed to the nearest 0.01g. Student 2 used an electronic balance that weighed to the nearest 0.001g.

	Student 1	Student 2
Measurement number	**Mass of object (g)**	**Mass of object (g)**
1	8.40	8.309
2	8.69	8.301
3	8.74	8.302
4	8.50	8.307
Average mass of object		

   Which one of the following statements is correct?

   J. The measurements of Student 2 were more accurate than the measurements of Student 1.

   K. The measurements of Student 2 were more precise than the measurements of Student 1.

   L. Student 1 should record the average mass as 8.46g.

   M. Student 2 should record the average mass as 8.30475g.

7. Aerobic respiration is a process that involves many small steps.

   In aerobic respiration

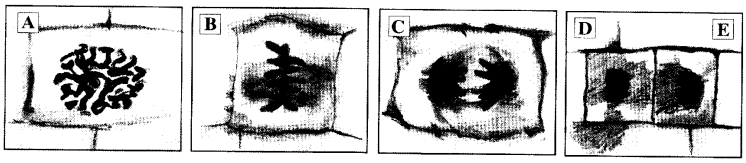
   J. one enzyme is involved and energy is consumed at different steps.

   K. several enzymes are involved and small amounts of energy are released at different steps.

   L. enzymes and a large amount of energy are consumed.

   M. several enzymes are involved and a large amount of energy is released at the end of the process.

8. Refer to the following diagrams, which show the appearance of a cell from a plant tissue undergoing mitosis.



The plant tissue has been grown for several generations in a culture medium containing radioactive DNA nucleotides. The level of radioactivity in each cell was measured and the results are shown in the table below:

Cell in diagram	Level of radioactivity (arbitrary units)
A	102
B	100
C	52
D	51

For which cell was the level of radioactivity incorrectly measured?

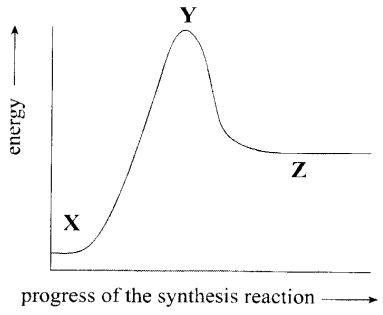
J. A

K. B

L. C

M. D

9. Refer to the following graph, which shows changes in energy during the process of a synthesis reaction. **X**, **Y**, and **Z** indicate stages in the progress of the synthesis reaction.



Which of the following statements about this synthesis reaction is correct?

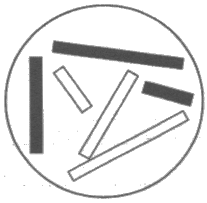
J. Between **Y** and **Z** an input of energy is required.

K. Between **Y** and **Z** energy is released as chemical bonds form.

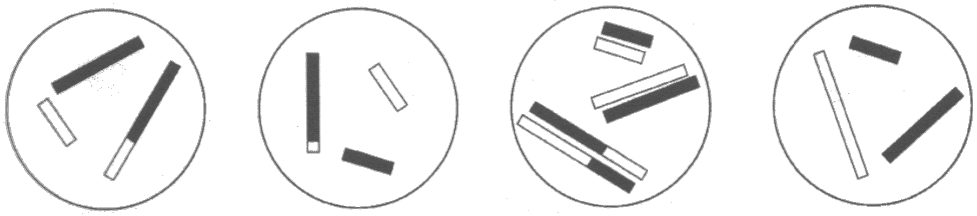
L. Between **X** and **Y** energy is released as chemical bonds break.

M. Between **X** and **Z** there is an overall release of energy.

10. Refer to the following diagram, which shows the chromosomes in a diploid cell of an organism.



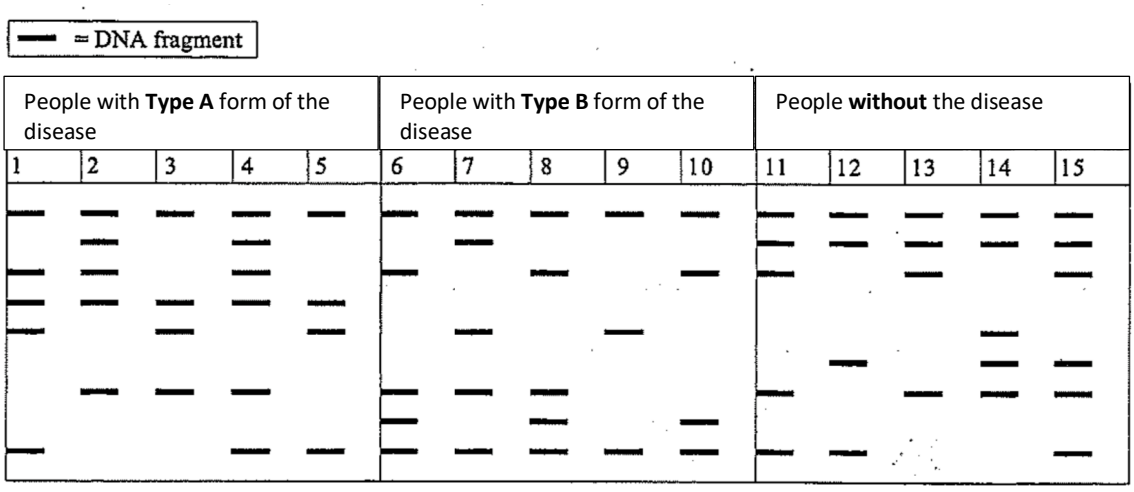
Which one of the following diagrams, J, K, L, or M, shows the product of a normal meiotic division in the organism, in which crossing over has occurred?



J. **K.** **L.** **M.**

11. Refer to the following diagram which shows the distribution of DNA fragments taken from a sample of 15 people. Five of the people had the Type A form of an inherited disease, five had the Type B form, and the other five did not have the disease.

DNA was extracted from the cells of each person and cut into fragments. The fragments were then separated according to their size using electrophoresis.



A marker is a DNA fragment found in all people with a form of a disease, but not in any person without that form of the disease. It was concluded that there…

J. was a marker for the Type A form but not for the Type B form of the disease.

K. was a marker for the Type B form but not for the Type A form of the disease.

L. were markers for both the Type A form and the Type B form of the disease.

M. was no marker for either the Type A form or the Type B form of the disease.

12. When using a gel electrophoresis procedure with DNA that has been cut up into restriction fragments

    J. the small DNA fragments will move short distances.

    K. the DNA will move from the positive to the negative terminal.

    L. the DNA fragments are visible to the eye as they move.

    M. the DNA fragments are compared to the DNA ladder.

13. Which one of the following statements about the regulation of secretion of the hormones insulin and glucacon 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.

14. 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.

15. Small pieces of RNA, called RNA interference (RNAi), can prevent the expression of specific genes. To do this they must first enter a cell.

    RNA molecules are negatively charged and therefore cannot readily dissolve in lipids. RNAi can be modified to be smaller and to have a reduced negative charge, thus making them lipid-soluble.

    Modified RNAi, but not other RNA

    J. could enter a cell through the membrane.

    K. could attach to ribosomes.

    L. would be produced by transcription.

    M. may contain thymine.

SECTION 2: Part A (Questions 16 to 21)
(49 marks)

*Answer **all** questions in this section.*

16. 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.

Steps in a normal cell	**Steps in a cell affected by progeria**
The gene LMNA codes for protein called prelamin A	
Farnesyl group attaches to the end of prelamin A	
Farnesyl group is removed from prelamin A	Farnesyl group remains *attached* to prelamin A
Normal form of prelamin A is called 'lamin A'	Abnormal form of prelamin A is called '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

(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)

17. 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)

18. It is estimated that in up to a third of seafood sales in Australia, the species has been incorrectly identified.

Explain how DNA sequencing can be used to determine the species being sold, and **discuss** either the ethical or the economic issues related to the collection of genetic information.

(8 marks)

19. Scientists studies a group of saltbush plants of the genus *Atriplex*. They measured the amount of CO_2 used by saltbush leaves (CO_2 use) and compared this with the amount of CO_2 produced by saltbush leaves (CO_2 production).
The scientists compared this ratio of CO_2 production ($U_{CO2} : P_{CO2}$) 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_2.

_____(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 $U_{CO2} : P_{CO2}$ has a value *greater* than 1:1.

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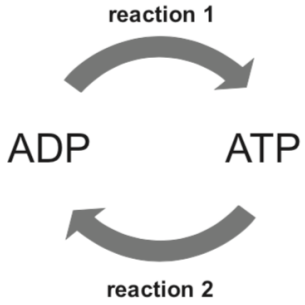
_____ (3 marks)

20. Refer to the following diagram:



(a) (i) Name a cellular process that provides energy for **reaction 1**, and describe the *role* that this energy has in **reaction 1**.

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_____(3 marks)

(ii) Describe **reaction 2** and explain its *importance* to cells.

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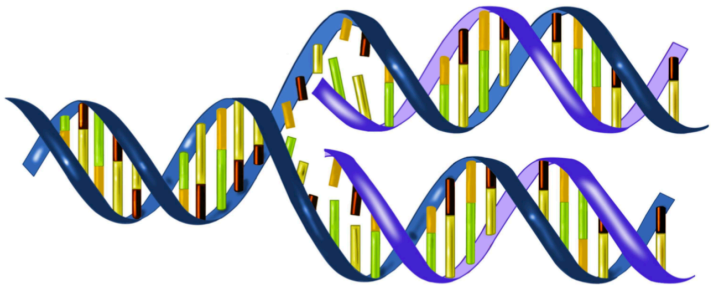
_____(3 marks)

(b) State the type of energy lost at each step of a metabolic pathway.

_____(1 mark)

21. Refer to the following diagram, which shows a process that occurs in all cells before they carry out cell division.



(a) Name the process pictured above.

_____ (1 marks)

(b) Explain why this process is said to be 'semi-conservative'.

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_____ (2 marks)

(c) Explain the key property of DNA that allows this process to occur accurately.

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_____ (2 marks)

(d) Stage one environmental factor that could change the base sequence of DNA.

_____ (1 mark)

(e) State one difference in DNA between prokaryotic and eukaryotic cells.

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_____

_____ (1 mark)

You may write on this page if you need more space to finish your answers to any questions in Part A of Section 2. Make sure to label each answer carefully (e.g. 19 (b)(i) continued).