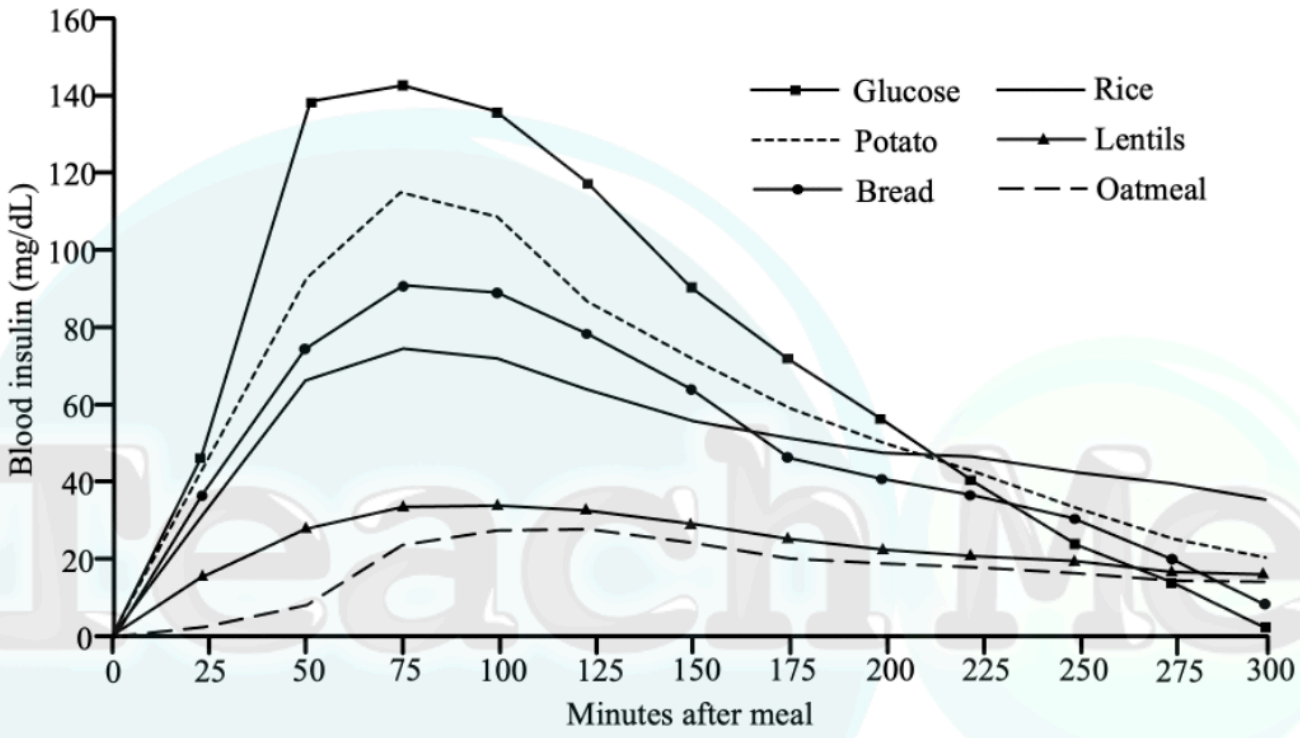
Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Diabetes is an ongoing world health problem which is associated with higher risks of heart attack, stroke, and kidney failure. In a study, laboratory bred sedentary BALB/c mice (*Mus musculus*) we divided into six groups, each of which was given a different diet: glucose, potatoes, bread, rice, lentils, or oatmeal.

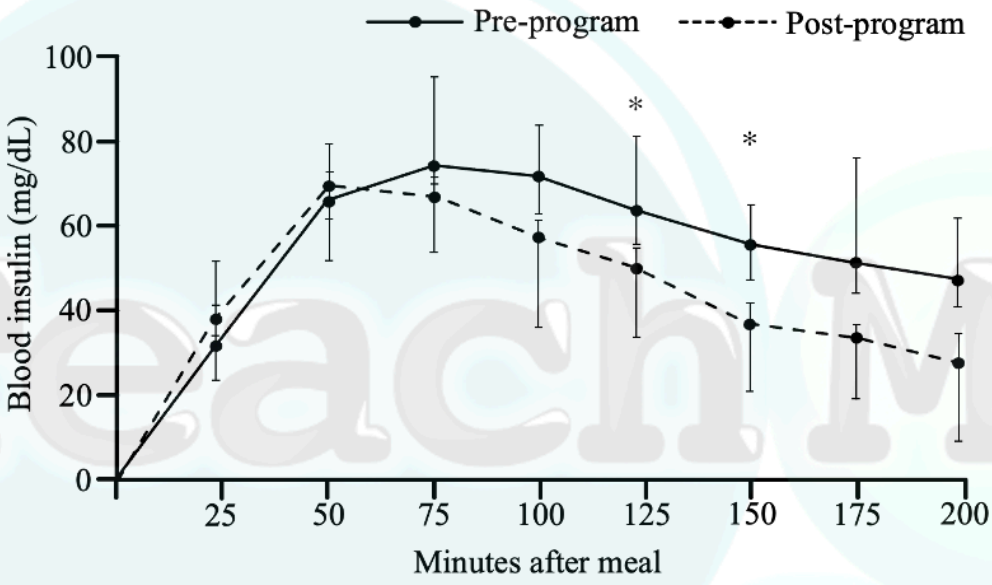


(a) Describe the overall trend in blood insulin levels for the six groups of mice. [2]

(b) Compare the blood insulin levels in the glucose group with the lentils group in the first 75 minutes. [2]

(c) Suggest a reason why it might be recommended for diabetic patients to rather consume their daily recommended carbohydrates in the form of lentils compared to potatoes. [1]

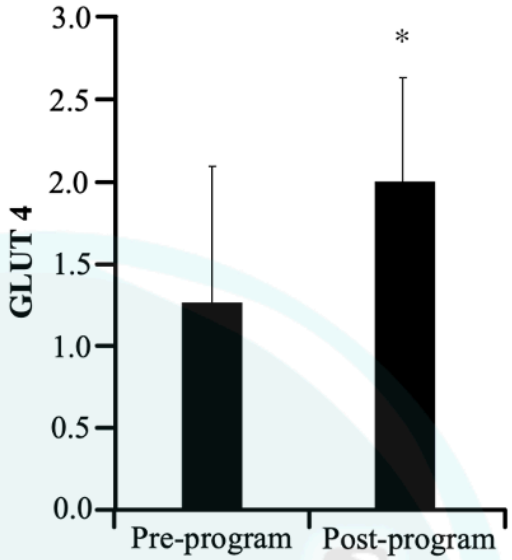
The same study then imposed a 12-weeks rigorous activity program to the rice group of mice. Their blood insulin level was then measured after a rice meal before starting the program and at the end of the 12 weeks.



(d) Distinguish between the results pre- and post-program. [2]

(e) Suggest why the mice need to fast before their meal during the experiment. [1]

The study also investigated the presence of GLUT4 proteins in the membranes of skeletal muscle in the mice before and after the program.



(f) Describe the difference in GLUT4 protein levels in skeletal muscle before and after the program. [1]

(g) Suggest how GLUT4 might contribute to improving insulin sensitivity. [1]

(h) Discuss the role of exercise in insulin sensitivity. [1]

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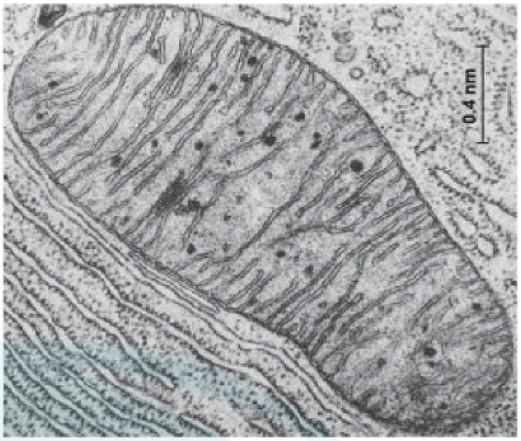
2. Below is a transmission electron micrograph (TEM) image taken of a mitochondrion.



(a) (i) Name an animal cell that does not have this organelle. [1]

(ii) State two cellular processes that requires ATP. [2]

(b) Suggest with a reason, from which parent mitochondrial DNA is inherited. [1]

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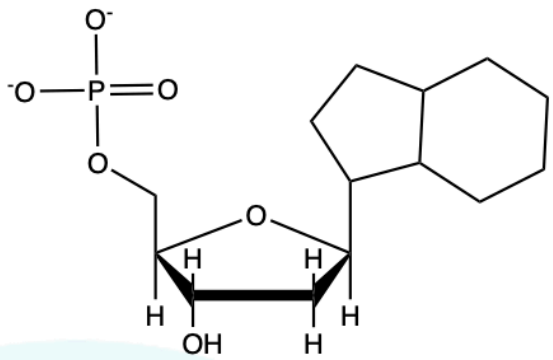
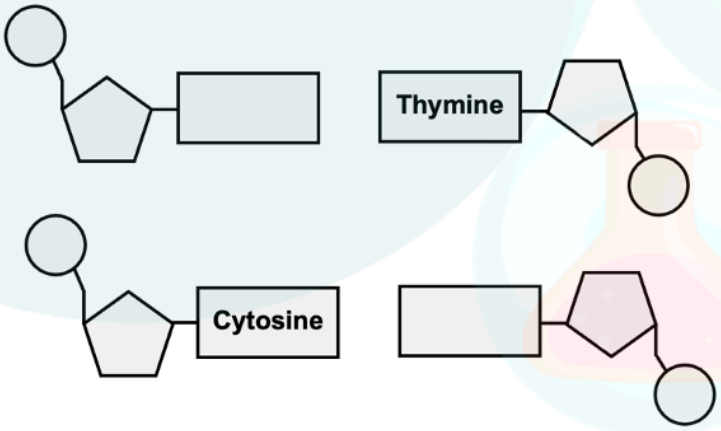
3. Below is nucleotide, a molecule known that comprises nucleic acids.



(a) Does this nucleotide comprise DNA, RNA or both? Outline the reasoning for your answer. [2]

(b) Complete the diagram below by:
(i) Filling in the names of the bases.
(ii) Drawing bonds in the appropriate places and labeling them. [3]



(c) Which nitrogenous base exists in RNA but not in DNA? [1]

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4. A man with blood group A and a woman with blood group B have a child with blood group O.

(a) Draw a Punnett square to show how this is possible. [2]

(b) Outline why hemophilia is more common in males than in females. [2]

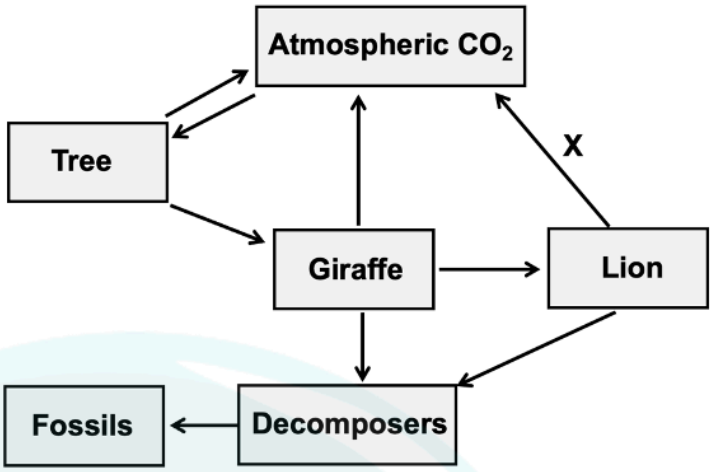
(c) State the role of crossing over in meiosis. [1]

5. (a) Define the term “enzyme”. [2]

(b) Sketch and label a graph showing the effect of substrate concentration on enzyme activity. [2]

(c) Suggest one reason why high temperatures can denature enzymes. [1]

6. This is a simplified representation of the carbon cycle:



(a) Annotate the diagram, illustrating an additional way through which CO_2 is removed from the atmosphere. [1]

(b) Discuss the effect of deforestation on carbon flux. [2]

(c) State the difference between detritivore and saprotrophic nutrition. [1]

Section B

Answer **one** question. One additional mark is available for the construction of your answer. Answers must be written within the answer boxes provided.

7. The immune system is a complex network of cells, tissues, and molecules that work together to defend the body against pathogens, such as bacteria while maintaining tolerance to self.

(a) Explain the process of endocytosis with reference to the innate immune response. [7]

(b) Outline how vaccines confer immunity. [4]

(c) Draw a labelled diagram of a bacterial cell. [4]

8. Hormones are chemical messengers transported through the bloodstream, and they play a pivotal role in regulating countless physiological processes including the menstrual cycle.

(a) Distinguish between arteries and veins. [4]

(b) Describe the function of hormones in regulating the menstrual cycle. [8]

(c) Discus the basic role of in vitro fertilization (IVF) in addressing infertility. [3]

References:

1. **Graph 1**
   Adapted from Jenkins DJ, Wolever TM, Taylor RH et al (1981) Glycemic index of foods: a physiological basis for carbohydrate exchange. Am J Clin Nutr 34(3):362–366.

   Graph 2
   Adapted from Croymans, Daniel M et al. "Resistance training improves indices of muscle insulin sensitivity and β-cell function in overweight/obese, sedentary young men." *Journal of applied physiology (Bethesda, Md. : 1985)* vol. 115,9 (2013): 1245-53. doi:10.1152/japplphysiol.00485.2013

   Bar Graph 1
   Adapted from Croymans, Daniel M et al. "Resistance training improves indices of muscle insulin sensitivity and β-cell function in overweight/obese, sedentary young men." *Journal of applied physiology (Bethesda, Md. : 1985)* vol. 115,9 (2013): 1245-53. doi:10.1152/japplphysiol.00485.2013

2. **Image**
   Adapted from Halliwell, Barry. "Cancer: A Redox Disease?" *ResearchGate*, 2013, https://www.researchgate.net/publication/256809470_Cancer_a_redox_disease.