C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

BIOLOGY

UNIT 2 – PAPER 02

$2\frac{1}{4}$ hours

Candidates are advised to use the first 15 minutes for
reading through this paper carefully.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1.   This paper consists of NINE questions.

2.   Section A consists of THREE questions. Candidates must attempt ALL
      questions in this section and should spend no more than 30 minutes on this
      section. Answers to this section MUST be written in this answer booklet.

3.   Section B consists of SIX questions. Candidates must attempt THREE
      questions in this section, ONE question from EACH module. Answers to this
      section MUST be written in the answer booklet provided.

4.   The use of silent non-programmable calculators is allowed.

SECTION A

You must attempt ALL THREE questions in this section. You should NOT spend more than 30 minutes on this section.

1.   Figure 1 below shows the materials and experimental apparatus A, B and C, used to measure oxygen uptake under three different circumstances.
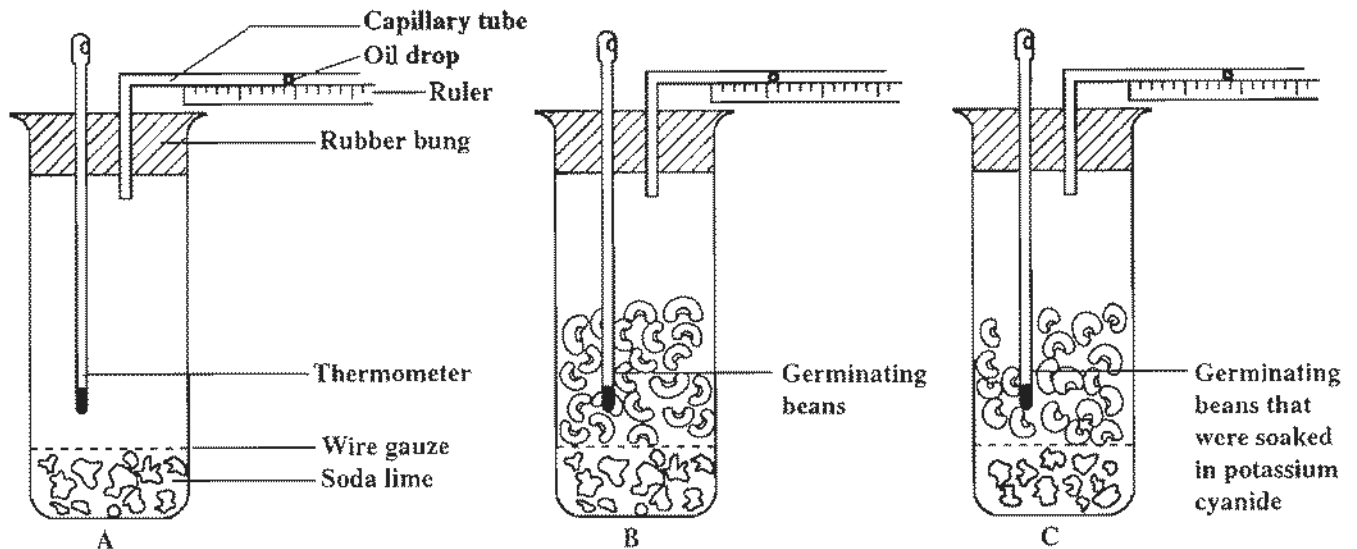

Figure 1. Oxygen uptake under different circumstances

(a)   Outline an experiment, based on the apparatus in Figures 1 A and B, to measure oxygen uptake in germinating beans.

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[4 marks]

(b)   What is the purpose of the thermometers used in the experimental apparatus in Figures 1 A and B?

_____

_____

[1 mark]

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(c) The beans in the experiment shown in Figure 1 C are soaked in potassium cyanide.

Suggest whether the beans soaked in potassium cyanide will take up oxygen. Give ONE reason for your answer.

_____

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_____

[2 marks]

(d) Figure 2 below shows the scheme for an experiment. The experiment has been designed to test whether a hydrogen ion (H^+) gradient can drive ATP synthesis by isolated mitochondria.
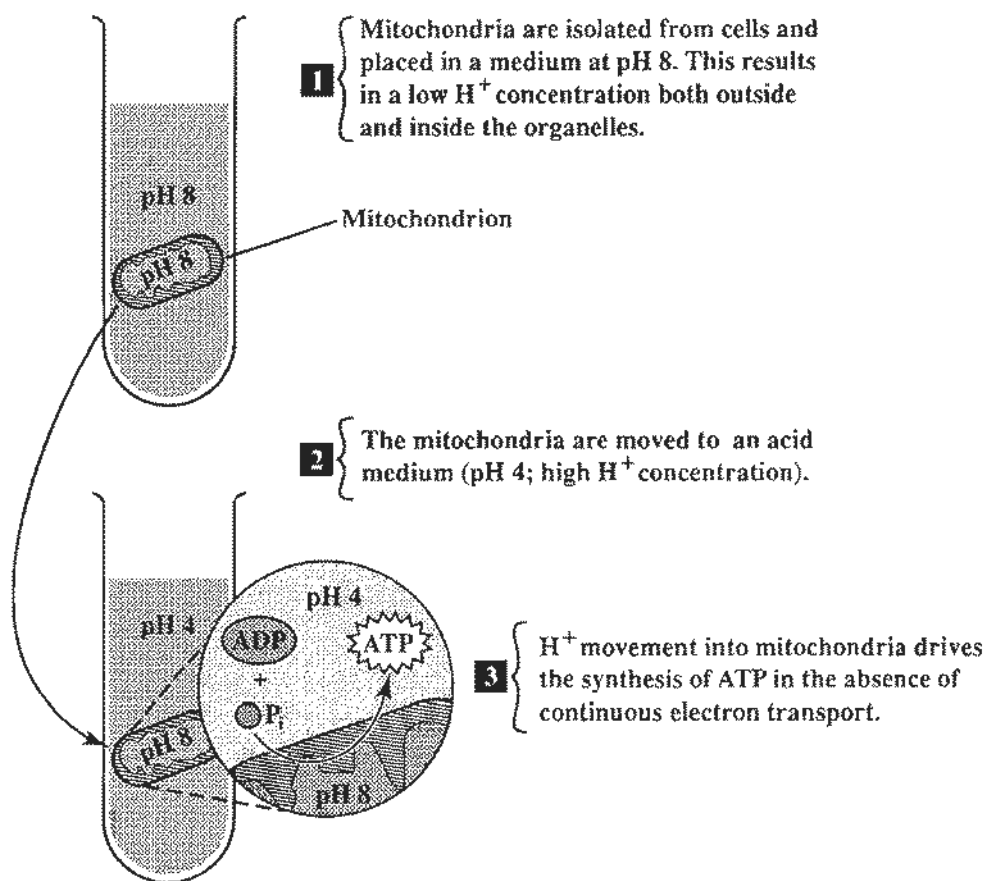

1 Mitochondria are isolated from cells and placed in a medium at pH 8. This results in a low H^+ concentration both outside and inside the organelles.

Mitochondrion

2 The mitochondria are moved to an acid medium (pH 4; high H^+ concentration).

3 H^+ movement into mitochondria drives the synthesis of ATP in the absence of continuous electron transport.

Figure 2. Experiment 1

What conclusion can be drawn from the results of Experiment 1?

_____

_____

_____

[1 mark]

(e) Another experiment is designed to test the role of H^+ pumps in ATP synthesis. An artificial lipid vesicle with a proton pump is created and ATP synthase inserted into the membrane. Hydrogen ions, pumped into the vesicle to create a gradient, diffuse out through the ATP synthase, producing ATP.

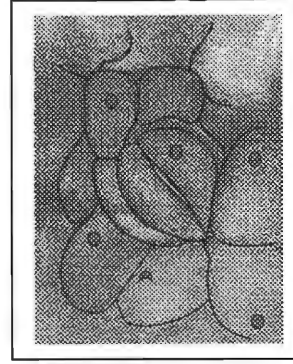What conclusion can be drawn about the conditions necessary for ATP synthase to form ATP?

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_____

_____

[2 marks]

Total 10 marks

2. (a) Figure 3 shows the stoma from the under surface of a leaf. In (A) the stoma is open while in (B) it is closed.
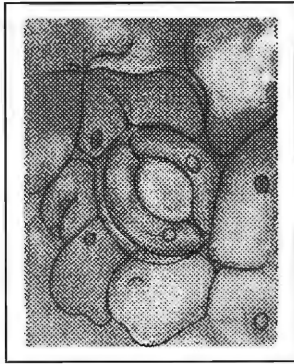
(A) Open   (B) Closed

Figure 3. Stomata

Draw the stoma in Figure 3 (A) and the cells immediately surrounding it, as well as any other features of significance. The drawing should be twice the size of the specimen in the photograph (magnification x 2). Do not spend more than FOUR minutes on your drawing. **Labels are not required.**

[**4 marks**]

(b) Adjacent to the left guard cell in Figure 3 A is a long narrow cell called the "accessory cell to the guard cell".

Account for the difference in its shape in A as compared with B.

_____

_____

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_____

[**1 mark**]

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(c)   (i)   Figure 4 is a diagram frequently used in botanical textbooks to show the size of the stomatal aperture over a 24-hour period. Collect data from this diagram and use it to construct a histogram to show the relationship between the time and the width of the stomatal pore.
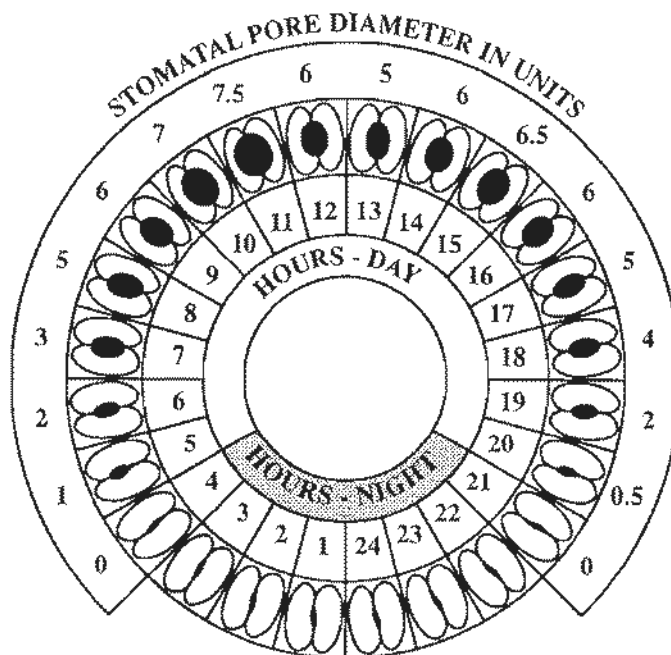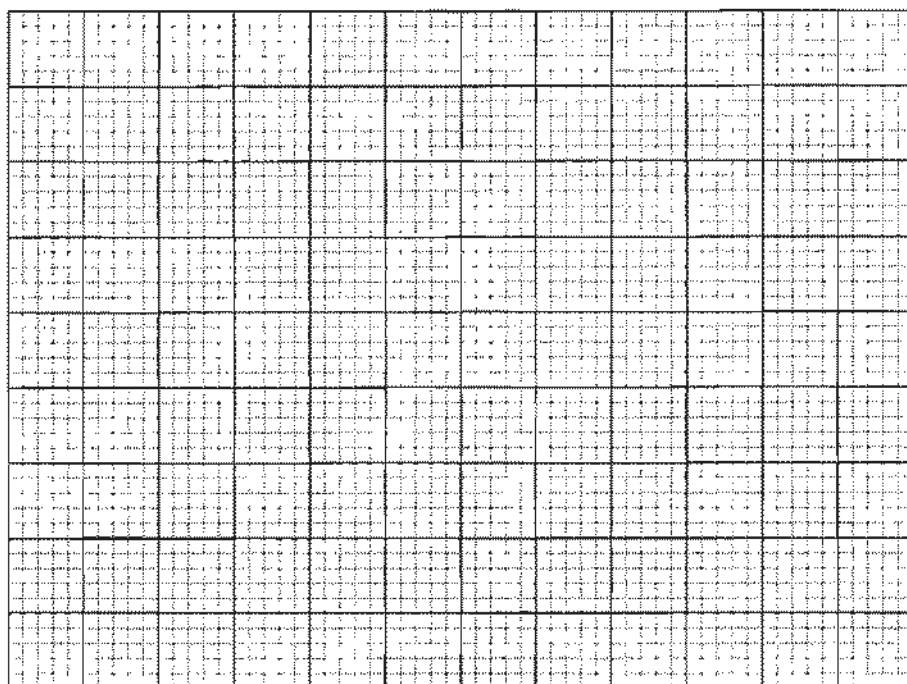

Figure 4. Stomatal pore-size over a 24-hour period

Histogram to show relationship between time and stomatal aperture

[4 marks]

(ii) Account for the shape of the histogram between 11.00 a.m. and 3.00 p.m.

_____

_____

_____

[1 mark]

Total 10 marks

3. (a) Light exercise creates little demand on the rate of breathing and heart output but as exertion and duration increase, both breathing movements and heart output intensify. When the body is exercising at its maximum capacity, oxygen consumption is at its highest. This state is called the VO_2 max. It is measured as the volume of oxygen in cubic centimetres, used per kilogram of body mass per minute.

$$VO_2max = O_2\ cm^{-3}\ kg^{-1}minute^{-1}$$

A sports lab is equipped with a stopwatch, a weighing scale, appropriate tubing and a gas analyser, to measure oxygen consumption.

Explain the procedures you would use and the calculations you would make to find out the VO_2max of an athlete.

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_____

[4 marks]

(b) A 40-year-old subject signed up for a 24-month endurance training programme. The graph in Figure 5 summarizes the adaptive changes in the muscles.

KEY s – aerobic enzymes in citric acid cycle
t – capillary network
u – VO$_2$ max
v – cross-sectional size of muscle fibres

Figure 5. Adaptive changes in muscles
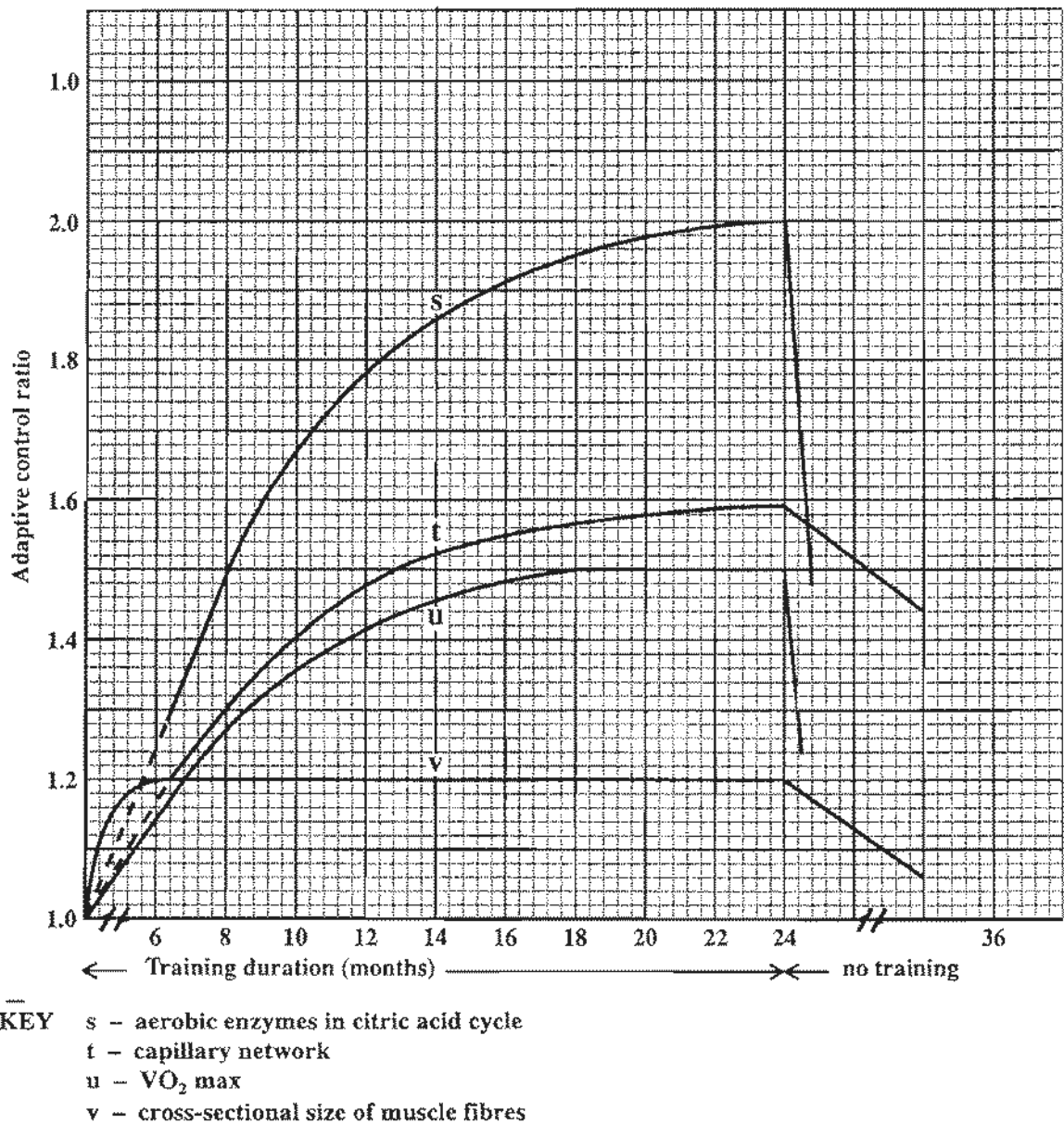
Adapted from Exercise Physiology: Energy, Nutrition and Human Performance, 5th Edition. W.D. Mc Ardle, F. I. Katch V. L. Katch. Lippincott Williams and Wilkins

With reference to the graph in Figure 5, answer questions (i) to (v).

(i) What is the percentage increase in VO$_2$max attained by the 40-year-old subject at the end of the 24-month period?

[1 mark]

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(ii)   Suggest why muscle fibres, which attain an increase in cross-sectional area in the first two months, do not achieve any further increase in diameter over the next 22 months.

_____

_____

_____

[1 mark]

(iii)   If the muscle cells do not increase in size, suggest how muscles continue to cause an increase in VO_2max.

_____

_____

[1 mark]

(iv)   At the end of 24 months, when training stops, why do curves 's' and 'u' decline abruptly, while curves 't' and 'v' decrease more slowly?

Reason 's' and 'u' decline abruptly: _____

_____

_____

[1 mark]

Reason 't' and 'v' decrease more slowly: _____

_____

_____

[1 mark]

(v)   Fitness instructors are advised to exercise at 50% of their VO_2max, to maintain health. On the graph in Figure 5 draw the letter X at the points which show the 50% VO_2max value at 18, 20 and 22 months.   [1 mark]

Total 10 marks

SECTION B

You must answer THREE questions in this section. Answer ONE question EACH from Modules 1, 2 and 3. You MUST write your answers in the answer booklet provided.

MODULE 1

Answer EITHER Question 4 OR Question 5.

4. (a) Explain how ATP and NADPH are synthesized in chloroplasts.   [10 marks]

    (b) The Calvin cycle stops in the dark.

    Briefly outline the THREE main processes of the Calvin cycle and discuss why the processes stop in the dark.   [6 marks]

    (c) Forty morning glory plants grow crowded together in a well-watered flower plot, under a sealed bell jar in full sunshine. Twenty morning glory plants grow in a poorly-watered flower pot in the shade, under a sealed bell jar with a lizard.

    Indicate, with reasons, FOUR factors which limit the rate of photosynthesis in the flower pots.   [4 marks]

    Total 20 marks

5. (a) (i) Difficulties with quantifying relationships between organisms in food chains led to the concept of pyramids of numbers.

        Explain how a pyramid of numbers is constructed **and**, by means of TWO examples, why there may be inconsistencies in the shapes of the pyramid.
        [5 marks]

        (ii) Pyramids of standing crop biomass are more accurate in recording trophic level measurements.

        Why are they more accurate **and** how do they vary seasonally?   [5 marks]

    (b) In temperate forests of Alaska there may be fewer than 50 species of trees and shrubs per hectare, while in forests of Guyana there are over 500 different species of trees and shrubs per hectare.

        (i) Discuss the effects of the variety of plant species in Guyana on the potential diversity of animal life.   [6 marks]

        (ii) Discuss how the stability of an ecosystem is related to its species diversity.
        [4 marks]

    Total 20 marks

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MODULE 2

Answer EITHER Question 6 OR Question 7.

6.   (a)   (i)   Describe the forces and conditions which cause blood from the right atrium to enter and fill the right ventricle.   [6 marks]

                   (ii)   The right and left ventricles force blood out of the heart at pressures of approximately 4 kPa and 16 kPa respectively. Why is this necessary?
     [4 marks]

         (b)   Discuss how the **blood vessels** of the circulatory system are well adapted, structurally and functionally to:

                   (i)   the distribution of blood   [4 marks]

                   (ii)   the return of blood   [3 marks]

                   (iii)   the interchange of substances with the tissues   [3 marks]

                                   Total 20 marks

7.   (a)   With specific reference to the cells, explain how the structure of phloem is related to its function.   [10 marks]

         (b)   A young bean seedling has two cotyledons, two developing leaves and one root. A sweet potato vine has a long stem, 40 mature leaves and four large sweet potatoes underground.

                   (i)   State CONCISELY the pressure flow hypothesis, CLEARLY distinguishing between a source and a sink.   [2 marks]

                   (ii)   Identify the sources and sinks in the bean seedling and in the sweet potato vine.   [4 marks]

         (c)   With reference to the bean seedling, outline the pathway a water molecule would take from the soil solution to the atmosphere via the xylem.   [4 marks]

                                     Total 20 marks

MODULE 3

Answer EITHER Question 8 OR Question 9.

8. (a) Describe the causes and effects of malnutrition with reference to:

   (i) Protein energy malnutrition (PEM)

   (ii) Anorexia   [8 marks]

   (b) The advice of dieticians is based on DRV.

   (i) What is meant by the abbreviation 'DRV'?

   (ii) State ONE advantage of fibre in the diet.   [2 marks]

   (c) A diet high in saturated fats is associated with atherosclerosis and coronary heart disease (CHD).

   Give reasons for this fact.   [10 marks]

                                                                   Total 20 marks

9. (a) State briefly what is meant by the following terms:

   (i) Humoral immune response

   (ii) Cell mediated immune response   [4 marks]

   (b) Explain what is meant by the term 'monoclonal antibody' and describe the use of monoclonal antibodies in ONE diagnosis and ONE treatment procedure.
                                                                          [6 marks]

   (c) (i) Distinguish between the two methods by which artificial immunity can be acquired AND suggest the advantages and disadvantages of this type of immunity.   [6 marks]

   (ii) **With reference to** the immune response generated, indicate how artificial immunity is beneficial to young children.   [4 marks]

                                                                   Total 20 marks

END OF TEST