TEST CODE **02107020**

FORM TP 2008160

MAY/JUNE 2008

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

BIOLOGY

UNIT 1 – PAPER 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions.
2. Section A consists of THREE questions. Candidates must answer ALL questions in this section. Answers to this section MUST be written in this question paper.
3. Section B consists of THREE questions. Candidates must answer ALL questions in this section. Answers to this section MUST be written in the separate answer booklet provided.
4. The use of silent non-programmable calculators is allowed.

SECTION A

Answer ALL questions in this section. You must write your answers in the spaces provided in this answer booklet.

1. Figure 1 shows the transverse section of the root of a dicotyledon. Study Figure 1 and answer Questions (a) to (c).

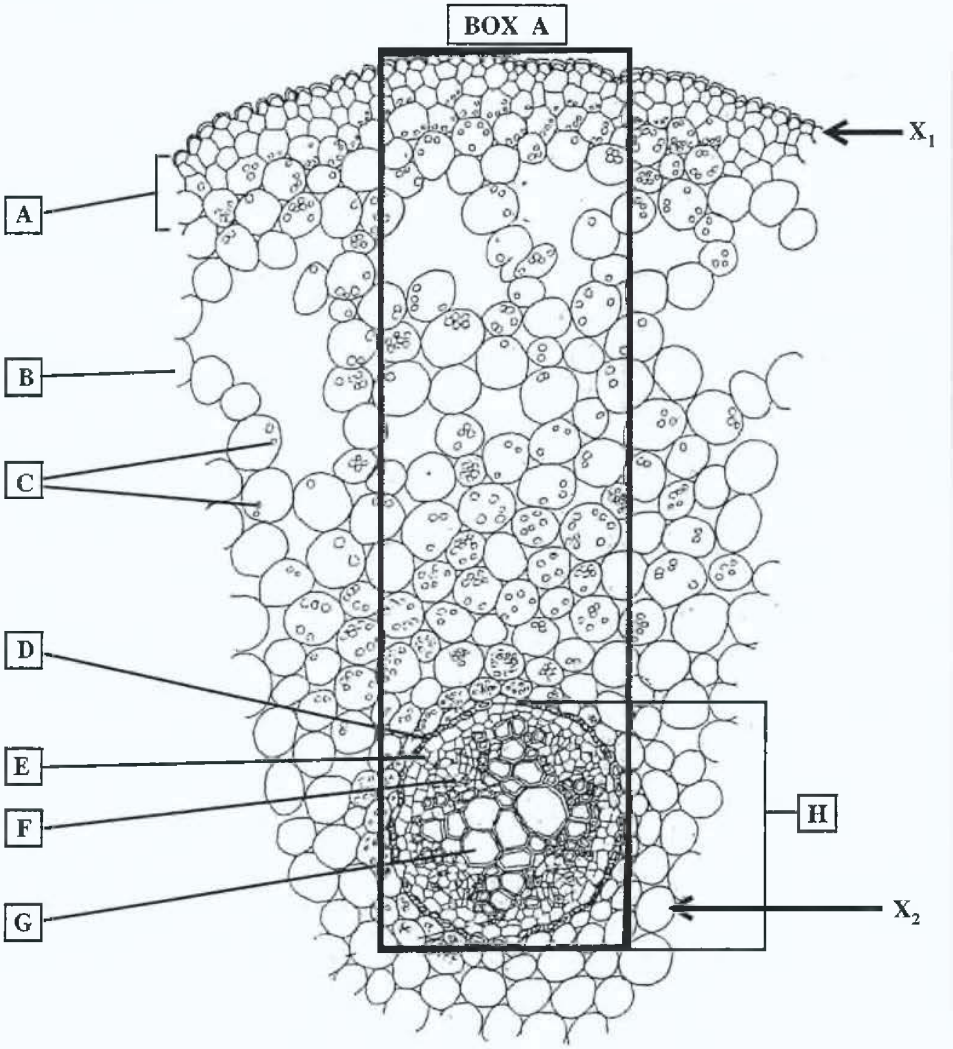


Figure 1. Transverse section of a dicotyledon root

Bracegirdle B. S. Miles P, An Atlas of Plant Structure Volume 1, Heinemann Educational Books, 1971, p.67.

(a) Identify the structures labelled A to H.

A _____ E _____

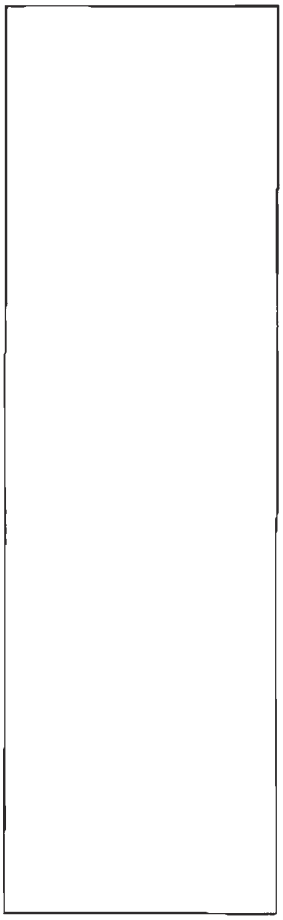
B _____ F _____

C _____ G _____

D _____ H _____

[4 marks]

(b) In the space provided, draw a plan diagram to show the distribution of the different types of tissues in Box A in Figure 1. Make your drawing the actual size of Box A. (No labels required).



[4 marks]

(c) If the photograph in Figure 1 has been magnified 100 times, what is the actual width of the specimen from X_1 to X_2?

_____

_____

[1 mark]

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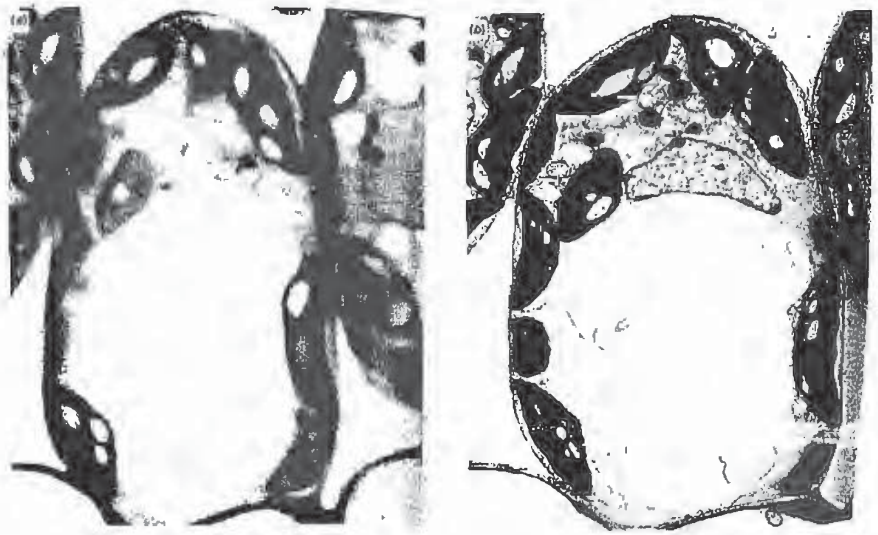
(d) Figure 2 shows photographs of the same plant cells seen (a) with a light microscope and (b) with an electron microscope. Both are shown at the same magnification of about x1500.



(a) (b)

Figure 2. Plant cells as seen by a light and an electron microscope

Biological Science 1 and 2, Taylor D. J. et al., Cambridge, page 132.

(i) Account for the difference in clarity between the two photographs.

_____

_____

_____

[2 marks]

(ii) Comment on the advantages and limitations of using a light microscope as compared to an electron microscope to examine cells or tissues.

_____

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_____

[4 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

2. Flower colour in certain plants is controlled by two genes. One gene codes for colour pigments in the petals, and its alleles are R (red) and r (white). The alleles are co-dominant. The other gene codes for an enzyme system in the petals that enables the pigments to be made, and its alleles are C for active enzymes and c for inhibited enzymes. Plants with homozygous recessive, cc are unable to synthesize any pigment, and therefore produce white flowers.

(a) A plant with genotype RRCC is crossed with the double homozygous recessive plant. State the genotype and phenotype of the F_1 plant.

(i) Genotype _____

(ii) Phenotype _____

[1 mark]

(b) State the FOUR different combinations of the alleles carried in the gametes of this F_1 dihybrid plant (plant produced in (a) above).

(i) _____

(ii) _____

(iii) _____

(iv) _____

[1 mark]

(c) (i) Use the Punnett Square shown in Table 1 to show the genotypes of the F_2 generation of this dihybrid cross.

TABLE 1: PUNNETT SQUARE

Gametes → ↓					

[2 marks]

(ii) Give the ratio of red : pink : white flowers.

Red _____ : Pink _____ : White _____

[3 marks]

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(d) A group of students determined the Chi-squared value from the figures shown in Table 2, which represent a monohybrid cross between CC (colour enzymes) and cc (no enzyme for colour).

TABLE 2: MONOHYBRID CROSS BETWEEN CC AND cc

	Colour, C	**No Colour, c**
Observed results (O)	95	35
Expected ratio	3	1
Expected results (E)	97.5	32.5
$O - E$		
$[O - E]^2$		
$[O - E]^2 \div E$		

Chi-squared is the sum of $\frac{[O - E]^2}{E}$ =

[4 marks]

(e) The students used the Table of Chi-squared values shown in Table 3 to determine whether the value you obtained in (d) on page 6 indicates that the difference between the observed and expected results are acceptable or not acceptable as being due to chance alone.

TABLE 3: TABLE OF χ^2 VALUES

Degrees of Freedom	Number of Classes	Chi-squared Values					
1	2	0.46	1.64	2.71	3.84	6.64	10.83
2	3	1.39	3.22	4.61	5.99	9.21	13.82
3	4	2.37	4.64	6.25	7.82	11.34	16.27
4	5	3.36	5.99	7.78	9.49	13.28	18.47
Probability that chance alone could produce this deviation		0.50 (50%)	0.20 (20%)	0.10 (10%)	0.05 (5%)	0.01 (1%)	0.001 (0.1%)

(i) How did the students determine the degrees of freedom?

_____

[1 mark]

(ii) The students checked the 5% probability in order to determine whether the result was significant or insignificant. What was their decision, and why?

_____

_____

[2 marks]

(iii) If the Chi-squared value had been 7.0, what information could have been gained concerning the results of the monohybrid cross experiment?

_____

_____

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[1 mark]

Total 15 marks

3. Figure 3 shows the structure of a mammalian ovum and sperm. Study Figure 3 and answer Questions (a) and (b).

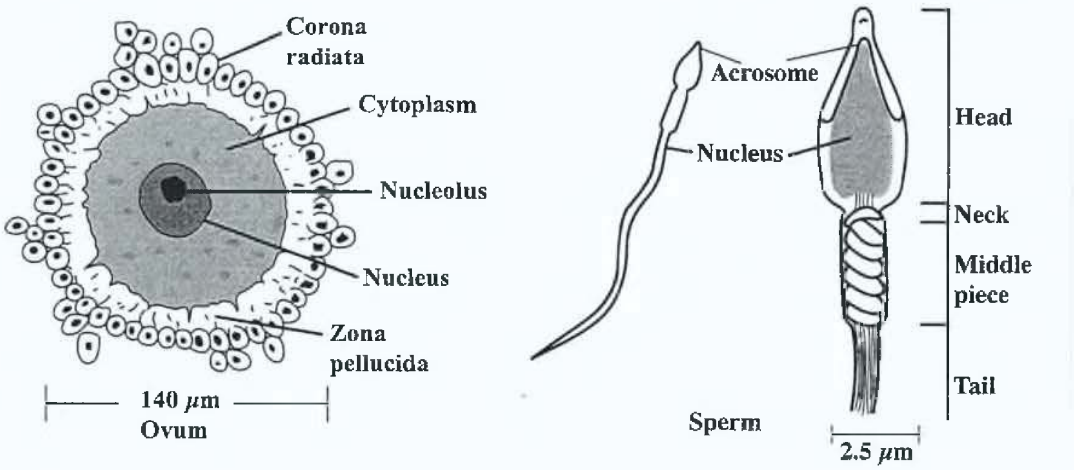

Figure 3. Structure of a mammalian ovum and sperm

http://www.humanillnesses.com/original/images/hdc_0001_0003_0_img0209.jpg

(a) (i) State FOUR structural differences observed between the ovum and the sperm.

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[4 marks]

(ii) Based on features observed, comment, using two points, on how the ovum and the sperm are suited to their respective functions.

[4 marks]

(b) Explain why some scientists regard the ovum at the stage shown in Figure 3, to be a secondary oocyte.

[2 marks]

(c) Table 4 shows the results of an experiment investigating the influence of sperm velocity on fertilisation in the freshly diluted sperm of the sea urchin, *Lytechinus variegatus*.

TABLE 4: SPERM VELOCITY AGAINST FERTILISATION IN SEA URCHIN

Sperm velocity mm/sec	No. of sperm/cm^3 needed to fertilise 50% of female eggs (F_{50}) expressed as a log value
0.15	3.6
0.16	3.3
0.17	4.1
0.19	3.5
0.20	4.0
0.21	3.2
0.22	3.1
0.25	2.5
0.26	2.6
0.28	2.0

(i) On the graph grid on page 11, plot a graph to show the relationship between sperm velocity and fertilisation. **[4 marks]**

(ii) Suggest a likely conclusion from the findings of this experiment.

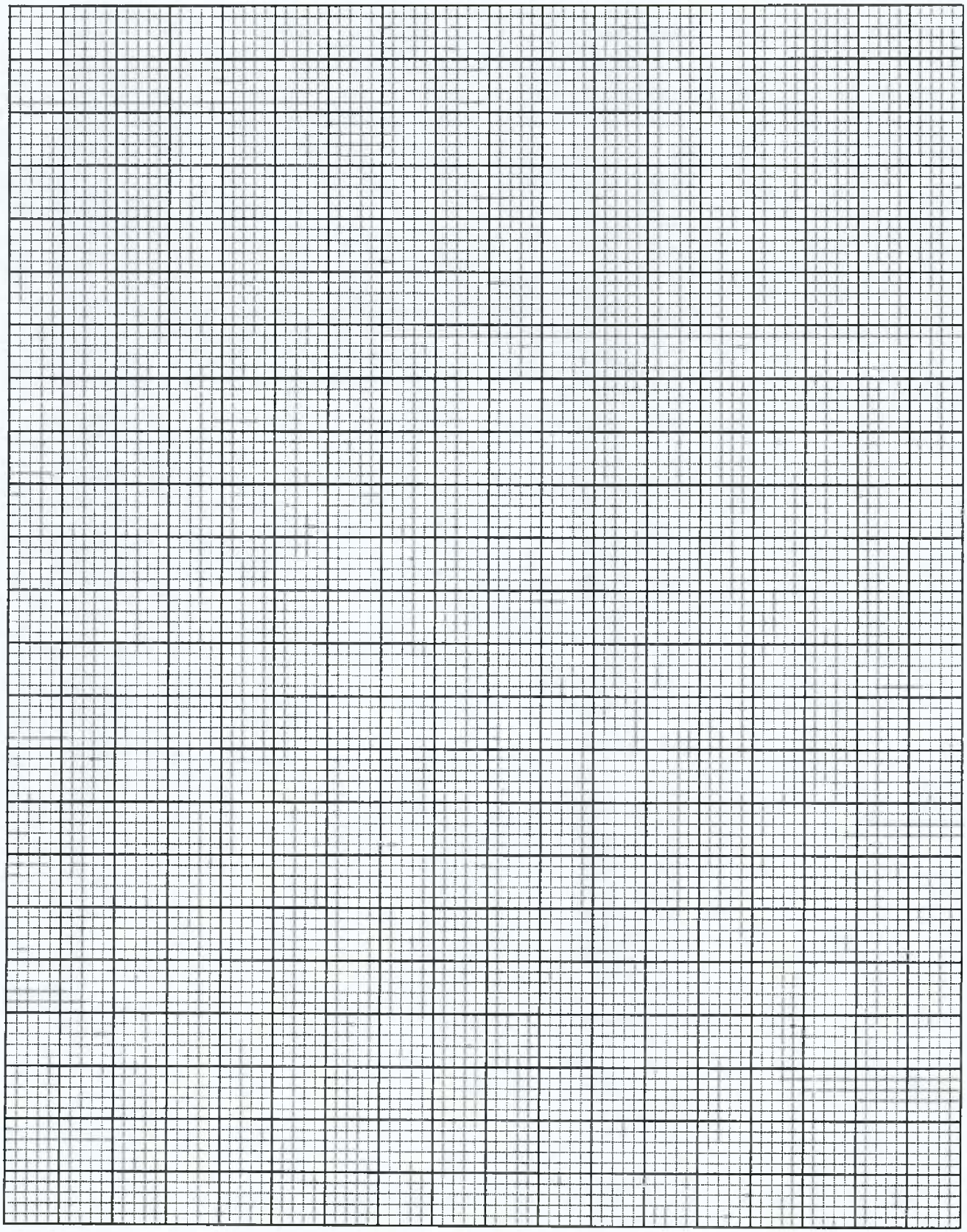
_____

_____

_____

[1 mark]

Total 15 marks



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SECTION B

Answer ALL questions in this section. You must write your answers in the answer booklet provided.

4. (a) By means of a diagram, show the molecular structure of sucrose. Show the position of the oxygen and all other groups, EXCEPT for the H.OH groups on the No. 2, 3 and 4 carbons of glucose, and the 1, 3 and 4 carbons of fructose. **[3 marks]**

   (b) Relate the structure of the water molecule to its

   (i) solvent properties

   (ii) high surface tension. **[4 marks]**

   (c) (i) Explain the mode of enzyme action according to the 'lock and key hypothesis'.

   (ii) Comment on differences in the way in which competitive and non-competitive inhibitors affect enzyme activity. **[8 marks]**

Total 15 marks

5. (a) State TWO ways in which variation can occur in sexually produced organisms and by means of a graph and an example, explain what is meant by EACH of the following:

   (i) 'Directional selection'

   (ii) 'Stabilising selection' **[7 marks]**

   (b) Outline the FOUR key steps involved in producing a recombinant piece of gene. **[4 marks]**

   (c) In general terms, discuss FOUR major issues associated with applications of genetic engineering. **[4 marks]**

Total 15 marks

6. (a) With reference to the human menstrual cycle, discuss the biological basis for the following two methods of contraception.

   (i) The rhythm method

   (ii) The contraceptive pill **[5 marks]**

   (b) Briefly comment on the role of the placenta as a guardian for the developing foetus. **[2 marks]**

   (c) Describe the structure of a young plant ovule. **[4 marks]**

   (d) Discuss the relative merits of cross-fertilisation and self-fertilisation in plants. **[4 marks]**

Total 15 marks

END OF TEST