FORM TP 2017152

TEST CODE **02107020**

MAY/JUNE 2017

CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

BIOLOGY

UNIT 1 – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in TWO sections. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. You may use a silent, non-programmable calculator to answer questions.
5. You are advised to take some time to read through the paper and plan your answers.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s) you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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SECTION A

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

1. (a) Figure 1 is a stained animal cell as seen under a light microscope.

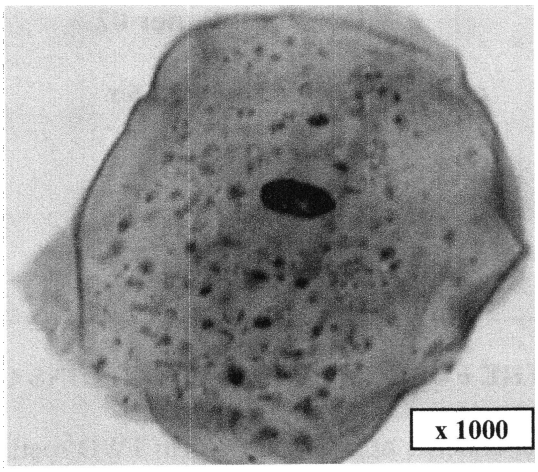

Figure 1. Animal cell

Source: http://imgarcade.com/

(i) In the box below, make a detailed drawing of the cell in Figure 1 and label FOUR structures seen in the cell.

[6 marks]

(ii) Using the magnification provided, calculate the actual size of the cell, highlighted by the bar line at the left of the image. State the calculated value to the nearest micrometer. **Show your working.**

Size: .....

[2 marks]

(b) An experiment is conducted to determine the amount of reducing sugar and starch in bananas at different degrees of ripeness. Extracts of equal quantities of tissue samples of bananas, at three different stages of ripeness, are prepared by mashing and grinding the samples in water. For each stage, sample extracts are placed in two sets of test tubes. A fourth test tube is set up with only water and no banana extract. Tests for reducing sugar and starch are conducted on all four test samples. The findings of the experiment are summarized in Table 1.

Note: For the Fehling's test the amount of the precipitate is measured as the ***height of precipitate (cm)*** *at the bottom of the test tube.*

TABLE 1: OBSERVATIONS OF SAMPLE EXTRACTS AFTER TESTING

Food Test		**Green Raw Banana**	**Half-ripe Banana**	**Ripe Banana**	**Water with no Banana Extract**
Fehling's Solution	Observation after heating	Greenish solution with red precipitate	Greenish solution with red precipitate	Greenish solution with red precipitate	Blue solution
	Height of precipitate (cm)	0.2	0.4	1.0	0.0
Iodine	Intensity of colour	Intense blue-black colour	Medium blue-black colour	Pale blue-black colour	Brown colour

(i) Suggest a hypothesis for this experiment.

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[1 mark]

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(ii) Compare the results obtained for the amount of reducing sugar and starch in the banana samples. Include in your comparison reference to the observations recorded.

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[3 marks]

(iii) Comment on the significance of the findings of this experiment in relation to the use of bananas as a food item.

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[2 marks]

(iv) State the purpose of testing a sample with no banana extract.

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[1 mark]

Total 15 marks

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2. (a) Haemophilia is a recessive sex-linked condition in humans in which the blood does not clot properly, leading to excessive bleeding. Use the symbols X^H for the normal allele and X^h for the haemophilia allele in your responses.

(i) State the genotypes of the following:

A normal clotting male .....,

A normal clotting carrier female .....

[2 marks]

(ii) Using the genotypes stated in (i) as parental genotypes, construct a Punnett square diagram to show how haemophilia-affected offspring can result from normal clotting parents. State the phenotype of all offspring.

[3 marks]

(iii) Give an explanation as to why a man with haemophilia cannot pass on the condition to his son.

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[1 mark]

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(b) A geneticist crossed two types of pea and obtained 5474 plants with round seeds and 1850 plants with wrinkled seeds in the F_2 generation. You are required to use the Chi-square test to show that these results are consistent with the 3:1 ratio normally expected from a monohybrid cross.

(i) State the null hypothesis for this test.

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[1 mark]

(ii) Calculate Chi-square using the formula, Chi-square = $\sum(O - E)^2/E$, where O is the observed and E the expected number of plants. Show your working in tabular form as follows.

Plant Type	Observed	Expected	O - E	$(O - E)^2$	$(O - E)^2/E$
Round seeds					
Wrinkled seeds					
				Chi-square =	

[2 marks]

(iii) Use the data in Table 2 on page 10 to make an inference based on your calculated Chi-square value.

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[2 marks]

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TABLE 2: STATISTICAL TABLE – CRITICAL VALUES OF CHI-SQUARE DISTRIBUTION

Degrees of Freedom	Number of Classes			χ^2 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 [p] that chance alone could produce the deviation		0.50 (50%)	0.20 (20%)	0.10 (10%)	0.05 (5%)	0.01 (1%)	0.001 (0.1%)

(c) The variation in size of an organism in a population is depicted in Figure 2.

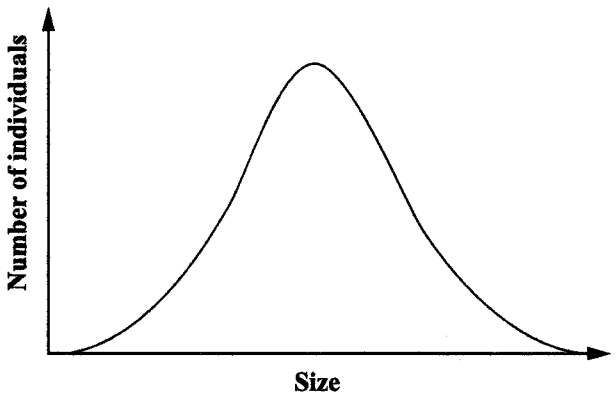

Figure 2. Size distribution of an organism in a population

(i) Using the axes provided in Figure 3, illustrate the effect of disruptive selection on the population distribution in Figure 2. **[1 mark]**

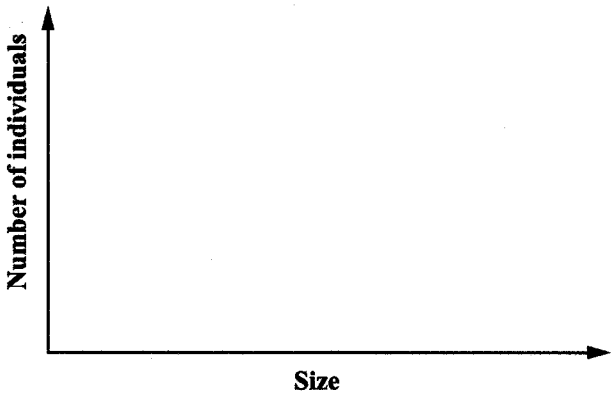

Figure 3. Effect of disruptive selection

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(ii) Using Darwin's theory of natural selection, explain how disruptive selection can lead to the formation of new species.

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[3 marks]

Total 15 marks

3. (a) An experiment is conducted to investigate the effects of type of culture medium and sucrose concentration on the pollen germination rate of a species of palm. Pollen grains are collected from newly opened flowers of the same bunch on the same day. The grains are inoculated into two types of medium: a liquid culture medium and a solid culture medium. The solid culture medium consists of different concentrations of sucrose in agar. The liquid medium is similar to the solid medium with respect to the sucrose concentrations but does not contain agar. The results of the investigation are given in Table 3.

TABLE 3: EFFECTS OF CULTURE MEDIUM AND SUCROSE CONCENTRATION ON POLLEN GERMINATION RATE IN A SPECIES OF PALM

	% Pollen Germination	
Sucrose Concentration ($g l^{-1}$)	**Liquid Culture Medium**	**Solid Culture Medium**
0	51	27
20	52	39
40	73	87
60	50	57
80	41	66
100	0	41

Source: American Journal of Plant Sciences, 2013, 4, 1669–1674.

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(i) On the grid provided in Figure 4, plot line graphs for the data given in Table 3.
[4 marks]

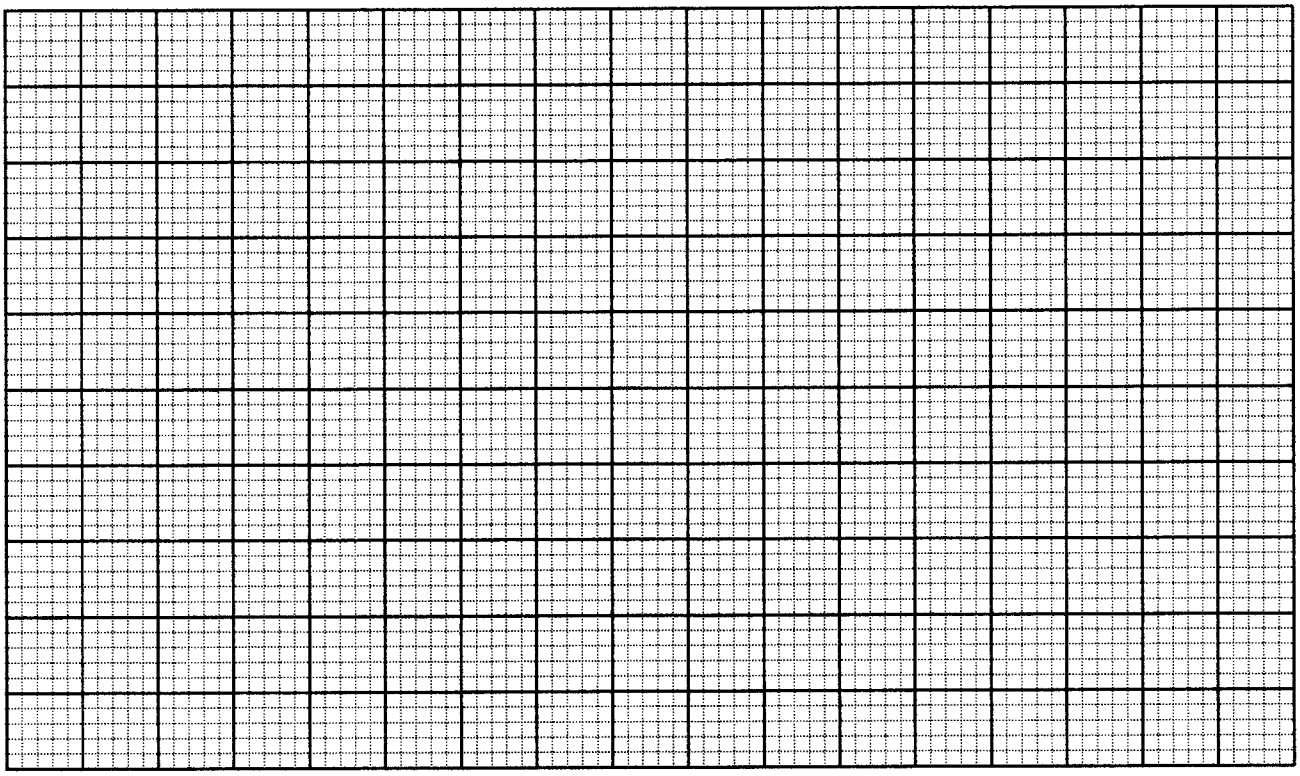

Figure 4. Effects of culture medium and sucrose concentration on pollen germination

(ii) Briefly describe the overall trend for the effect of different sucrose concentrations, in both culture media, on the germination rate of the palm pollen.

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[2 marks]

(iii) Based on the results shown in Table 3, what can be deduced about the effect of the type of culture medium on the maximum rate of pollen germination?

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[2 marks]

(b) Figure 5 is a drawing of a section through a human placenta *in situ*.

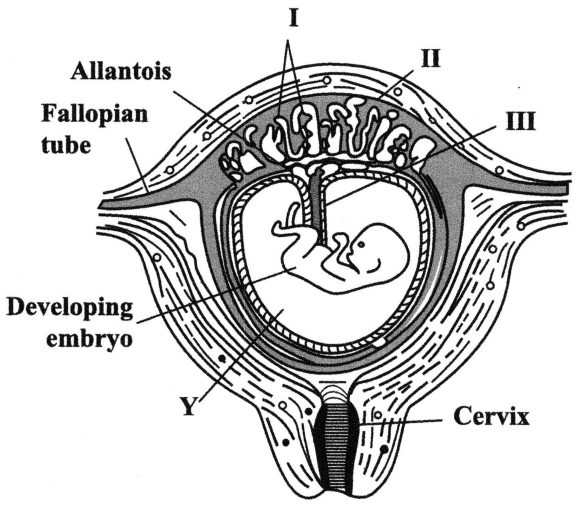

Figure 5. Section through a human placenta

(i) Identify and describe the main function of EACH of the structures labelled **I**, **II** and **III**.

I: .....

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II: .....

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III: .....

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[3 marks]

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(ii) Comment on TWO roles of the structure labelled **Y** in the development of the foetus.

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[2 marks]

(iii) Outline TWO ways in which the placenta acts as a protective barrier for the developing foetus.

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[2 marks]

Total 15 marks

SECTION B

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

4. (a) (i) Compare the cell size and THREE structural features of prokaryotic and eukaryotic cells.

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[4 marks]

(ii) Outline the endosymbiont theory for the origin of eukaryotic cells. Explain how characteristics of mitochondria and chloroplasts provide evidence in support of this theory.

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(b) Discuss the importance of protein structure for determining enzyme specificity and mode of action.

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[6 marks]

Total 15 marks

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5. (a) Describe the roles of DNA and RNA in protein synthesis.

[5 marks]

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(b) Genetic engineering and gene therapy are two closely related technologies with promising potential for improving human health.

(i) Outline the principle of genetic engineering, including a brief description of the basic steps of this technique.

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[5 marks]

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(ii) Despite its promising potential, one of the arguments sometimes raised against the use of gene therapy is that it is technically too dangerous. With reference to cystic fibrosis, discuss reasons for this viewpoint.

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[5 marks]
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6. (a) Giving examples, discuss TWO advantages of vegetative propagation of plants.

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(b) Discuss TWO genetic consequences of sexual reproduction.

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[4 marks]

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(c) Describe the development of fruit and seed structures from floral structures after fertilization.

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[6 marks]

Total 15 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.