



TEST CODE **002371**

FORM TP 23176

MAY/JUNE 2003

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

BIOLOGY

UNIT 1 – PAPER 01

1½ hours

In addition to the 1½ hours, candidates are allowed a reading time of 15 minutes. Candidates may write in their answer booklets during this 15-minute period.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. Candidates must attempt ALL questions in this paper.
2. Answers are to be written in the spaces provided in this answer booklet.
3. EACH question is worth 10 marks.
4. The use of silent non-programmable calculators is allowed.

1. Figure 1 below is an electron micrograph of a cell from the leaf of a maize plant.

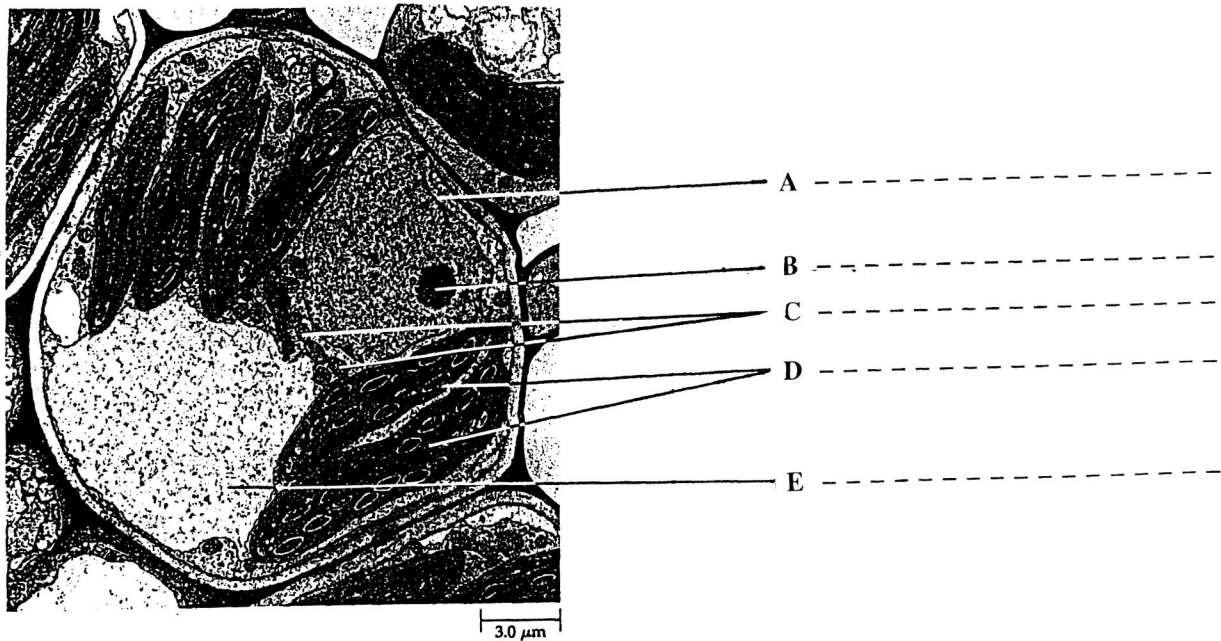


Figure 1

*Biology of Plants, 6th Ed. P.H. Raven, R.F. Evert, Susan E. Eichhorn.
W.H. Freeman and Company, Worth Publishers, 1999.*

- (a) Name the structures at positions A to E in the plant cell in Figure 1 above. [4 marks]

- (b) (i) The amoeba, *Pelomyxa palustris*, hosts a permanent population of aerobic bacteria in its cytoplasm. A species of *Paramecium* hosts green unicellular algae in its cytoplasm. With reference to the endosymbiont theory, deduce which cellular organelles perform functions similar to those of aerobic bacteria and green algae, and insert your answer in the table below.

Organism	Organelle
Aerobic bacteria	_____
Green algae	_____

- (ii) Name TWO organelles or structures, present in animal cells, that are not present in plant cells.

[2 marks]

- (c) Distinguish between a tissue and an organ.

[2 marks]

- (d) Figure 2 below shows the distribution of tissues in the skin.

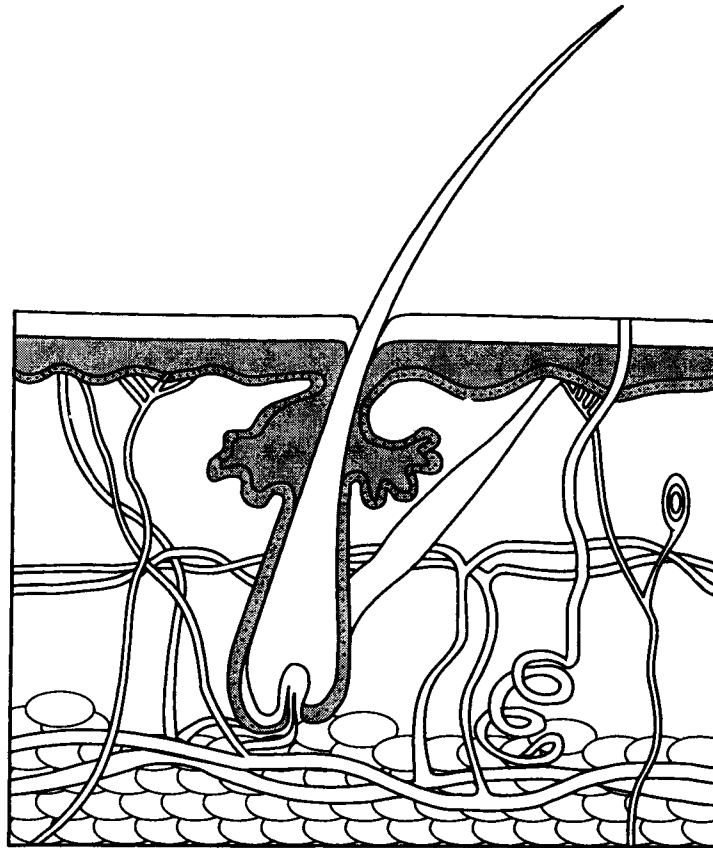


Figure 2

First-degree burns are painful and heal from epidermal cells. Second-degree burns heal from cells at the burn edges, for example, hair follicles.

On Figure 2 **above**, insert labelled, horizontal lines across the diagram to show the depth of tissue affected in

- (a) first-degree burns (labelled '1st degree')
- (b) second-degree burns (labelled '2nd degree')

[2 marks]

Total 10 marks

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2. (a) Explain what is meant by the term 'enzyme'.

[1 mark]

- (b) Figure 3 is a graph that shows the effect of temperature on the rate of an enzyme catalysed reaction.

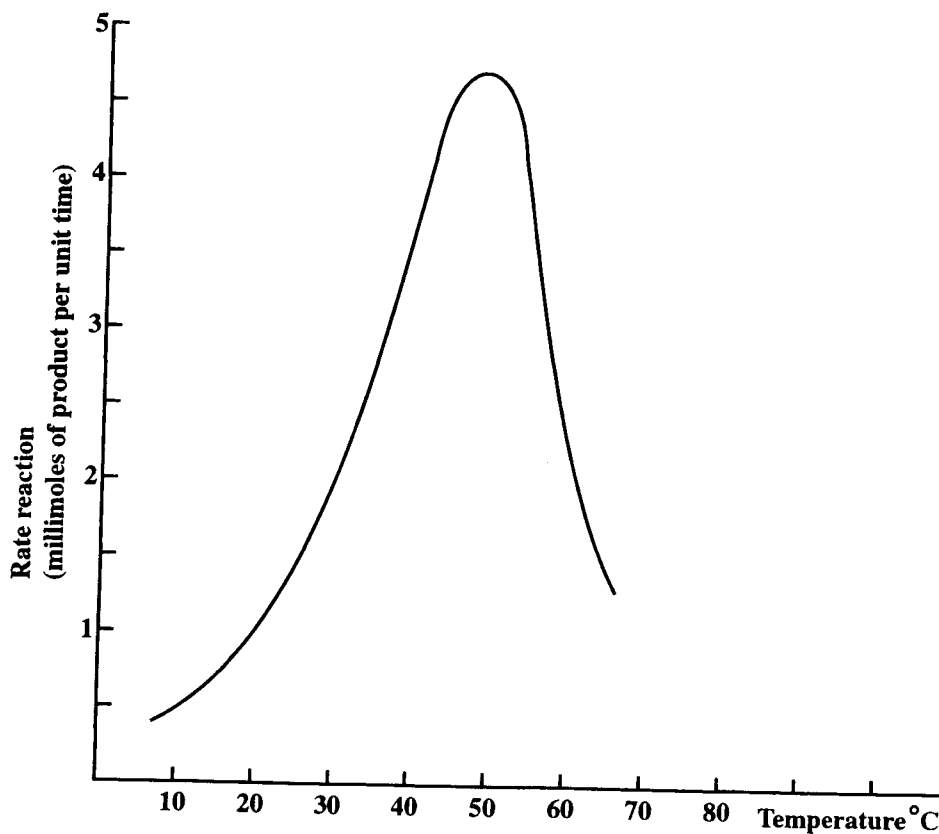
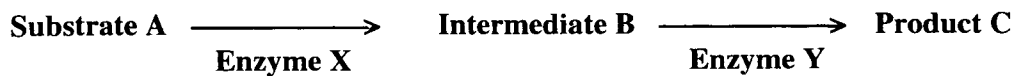


Figure 3

With reference to the graph above, describe the effect of temperature on the rate of the enzyme catalysed reaction.

[3 marks]

- (c) Enzyme X acts on substrate A, to produce an intermediate substrate B. Enzyme Y acts on substrate B, to produce product C:



As the levels of product C increase, the reaction rate of X is reduced.

- (i) What type of inhibition is product C causing?

[1 mark]

- (ii) If an agent that removes substrate B from the reaction mixture is added, deduce the effects this would have on the reaction.

[3 marks]

- (d) Explain why enzymes are required to catalyse reactions in living organisms.

[2 marks]

Total 10 marks

3. (a) Figure 4 shows a fluid mosaic model of a cell membrane.

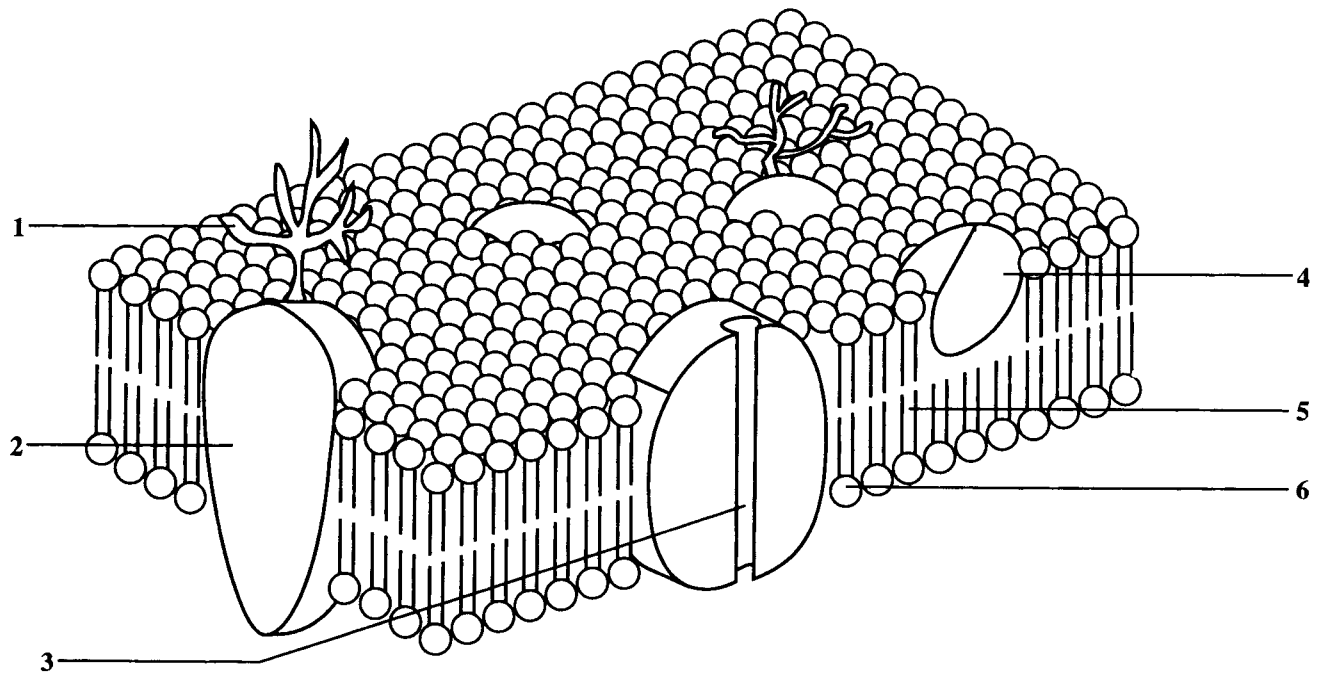


Figure 4

- (i) Label structures 1 to 6 in the spaces provided.

1 _____	2 _____
3 _____	4 _____
5 _____	6 _____

[3 marks]

- (ii) State the function of EACH of the following:

Structure 1 _____

Structure 3 _____

[2 marks]

- (b) If this membrane belongs to a white blood cell which is engulfing a bacterium, the membrane must be adjusted to incorporate it. Suggest how the properties of the bilayer of molecules labelled 5 and 6 in Figure 4, on page 6, enable the membrane to enclose the bacterium into a vacuole, without leaving gaps or holes in the continuity of the membrane.

[3 marks]

- (c) Plant cells are surrounded by a cellulose cell wall. Structures 3 and 4 in Figure 4 assist in building this wall. Suggest how they do this.

[2 marks]

Total 10 marks

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4. (a) In sickle cell anaemia, a mutation occurs in the DNA sequence of the β - globin gene. Examine the DNA strands below and indicate, with a pair of brackets, where the base pair mutation has occurred.

(i) **DNA strand for Normal Adult β - globin gene**

3' C C T G A G G 5'
 G G A C T C C

DNA strand for Sickle-cell β - globin gene

3' C C T G T G G 5'
 G G A C A C C

[1 mark]

- (ii) Write the structure of the mRNA for the mutated sequence.

_____ [1 mark]

- (b) Figures 5.1 and 5.2 below show two forms of red blood cells.

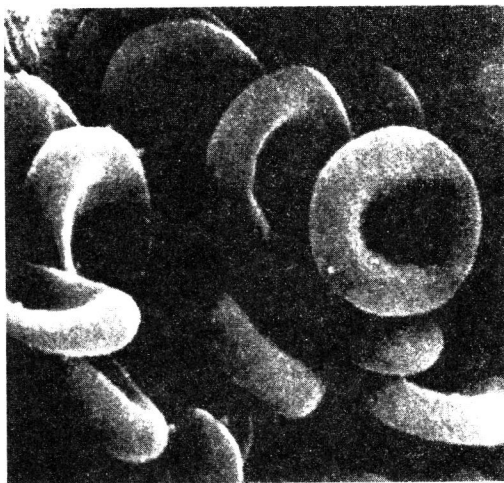


Figure 5.1

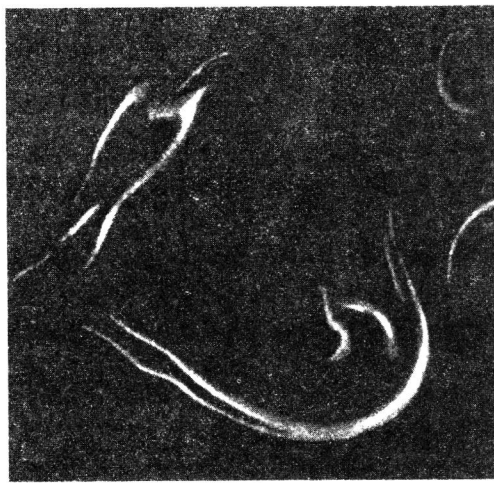


Figure 5.2

*Biology Life on Earth, 5th Ed. Tresa Audesirk, Gerald Audesirk, 1999.
Prentice Hall, Upper Saddle River, New Jersey.*

- (i) Outline the conditions under which the shape of the red blood cells in Figure 5.1 will become changed to the shape seen in Figure 5.2.

_____ [1 mark]

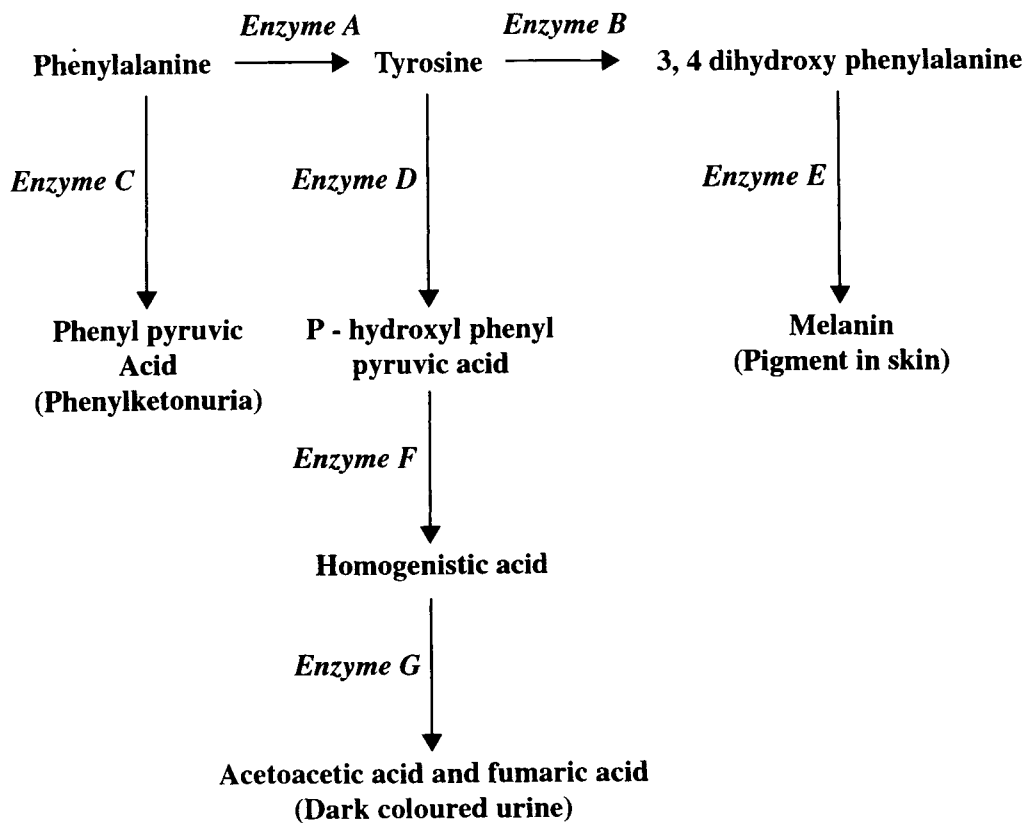
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- (ii) Explain what happens inside the red blood cell to cause this change in shape.

[2 marks]

- (c) The inherited human disorders phenylketonuria, albinism (absence of pigment in skin) and alkaptonuria (dark coloured urine) are due to defects in phenylalanine – tyrosine metabolism. The mutations result in the synthesis of inactive enzymes at different steps in the metabolism.

Examine the pathways in the diagram below which show the steps in phenylalanine metabolism.



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Indicate in the following table, which specific enzyme is inactivated to give EACH of the conditions listed.

Condition	Inactive Enzyme
Albinism	
Phenylketonuria	
Dark coloured urine	

[3 marks]

- (d) The red alga *Chondrus crispus* (Irish moss) stores its genetic information in double stranded DNA. When DNA was extracted from *C. crispus* cells and analysed, 32 per cent of the bases were found to be guanine residues.

Showing your working, determine the percentage of cytosine and thymine residues in the DNA of *C. crispus*.

[2 marks]

Total 10 marks

5. Figure 6 indicates the volume of DNA in the nucleus of a cell P, in the pollen sac at different times.

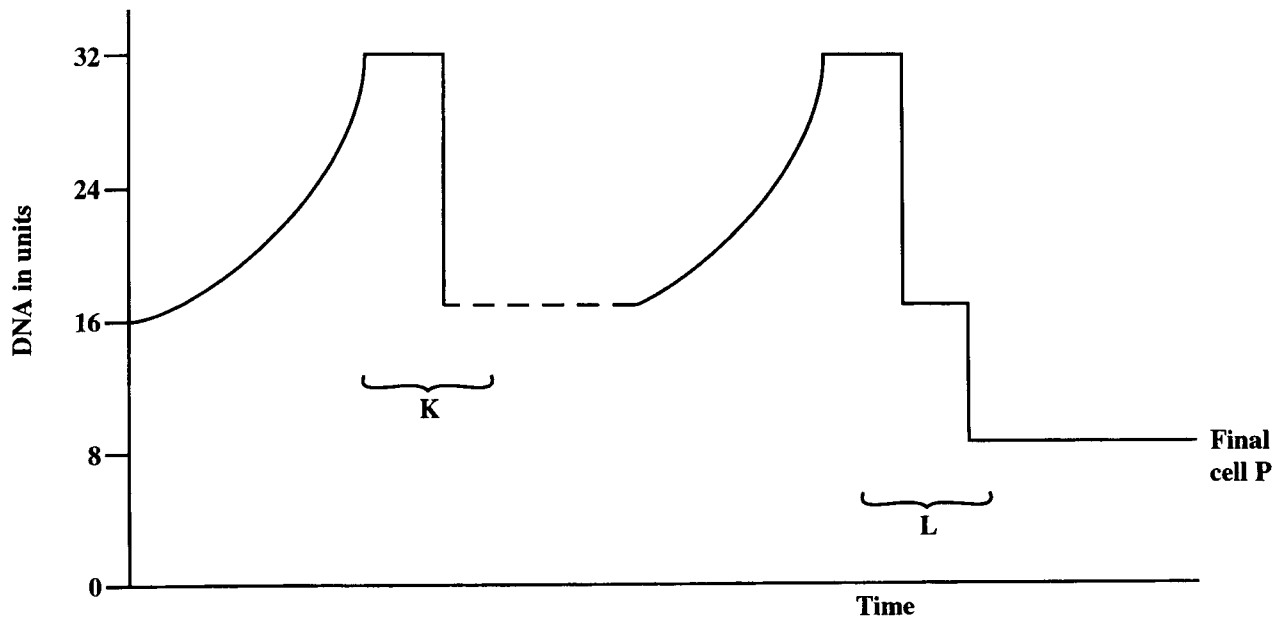


Figure 6

- (a) Determine, with reasons, what process has occurred at EACH of the following stages:

(i) K _____

_____ [2 marks]

(ii) L _____

_____ [2 marks]

- (b) What type of cell is final cell P, and what is its intended fate?

(i) Type of cell _____
(ii) Fate _____
_____ [2 marks]

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- (c) Complete the table below, listing differences between gametogenesis in the testes and ovaries.

Difference	Gametogenesis: Testes	Gametogenesis: Ovaries
1		
2		

[2 marks]

- (d) (i) State ONE hormone present in the female contraceptive pill.

[1 mark]

- (ii) State ONE function of testosterone.

[1 mark]

Total 10 marks

6. (a) Figure 7 is a diagram of the synthesis of a polypeptide from messenger RNA. Carefully examine the diagram and answer the following questions.

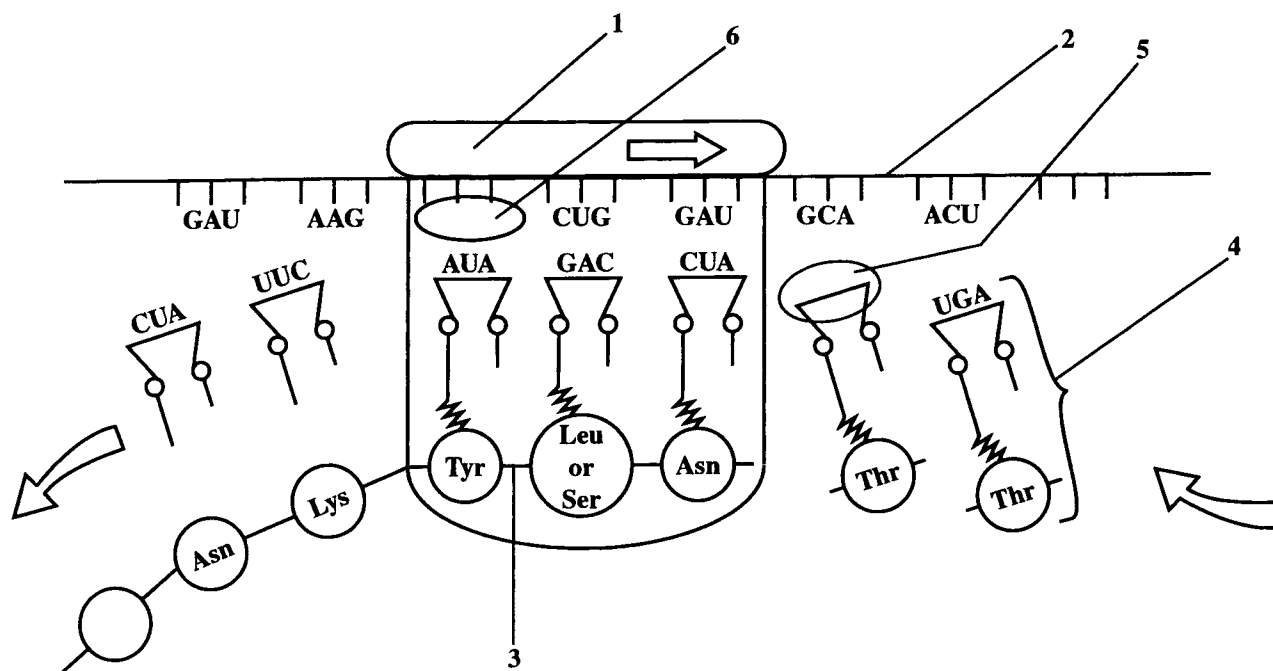


Figure 7

- (i) Label parts 1 to 4 in Figure 7 above.

1. _____ 3. _____
 2. _____ 4. _____ [2 marks]

- (ii) State the sequence of bases in the missing triplets at 5 and 6 in Figure 7.

5. _____ 6. _____ [2 marks]

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- (b) (i) Cancer can be treated by chemotherapy. One of the molecules successfully used in treatment is 5- fluoro-uracil which is similar, but not identical to uracil. If this molecule is given in medication in high doses, suggest how it might impair the production of polypeptides in the process shown in Figure 7.

[3 marks]

- (ii) In 1993, scientists found that one of the t-RNA molecules showed mutant behaviour. The RNA codon is CUG, and the t-RNA anticodon is GAC. With reference to Figure 7, explain how this mutant t-RNA could affect the nature of the polypeptide produced.

[3 marks]

Total 10 marks

7. (a) Define the terms 'recessive allele' and 'dominant allele'.

[2 marks]

- (b) Sparrows from wild populations typically have brown feathers. In a certain laboratory strain, a number of yellow-feathered individuals occur. A yellow sparrow is mated with a brown sparrow. The results are shown below.

Parents	Yellow	X	Brown
F₁ Progeny	44 yellow		40 brown

The F₂ progeny is produced by mating brown sparrows from the F₁ among themselves and yellow F₁ progeny among themselves. The results are shown below.

F₁ Parents	Brown	X	Brown		Yellow	X	Yellow
F₂ Progeny	84 brown				23 brown		61 Yellow

Box 1

Box 2

- (i) Deduce which feather colour is caused by a dominant allele and which is caused by a recessive allele. Give your reasoning.

[3 marks]

- (c) (i) Use the Chi-square test to determine if the data from the F_2 matings, between yellow-feathered sparrows as shown in Question 7 (b), Box 2, on page 15 agree with the expected outcome.

F_2 Phenotype	Observed (O)	Expected (E)	$\frac{(O - E)^2}{E}$
Yellow	61		
Brown	23		
Total	84		

$$\Sigma \frac{(O - E)^2}{E} = \underline{\hspace{2cm}}$$

Degrees of freedom = $\underline{\hspace{2cm}}$

[4 marks]

Use the Table of Chi-Square below to answer question (c) (ii).

TABLE OF CHI-SQUARE (χ^2) 5 % CRITICAL VALUES

<i>Degrees of Freedom</i>	<i>5 % Critical Value</i>
1	3.841
2	5.991
3	7.815
4	9.488
5	11.070
6	12.592
7	14.067
8	15.507
9	16.919
10	18.307

- (ii) State whether you accept or reject the hypothesis that the feather colours are segregating in a Mendelian fashion? Give the reason for your answer.

[1 mark]

Total 10 marks

8. (a) Figure 8 shows TWO chromosomes.

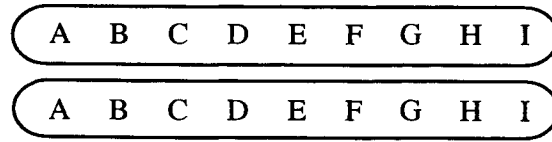


Figure 8

Using the Tables A and B below, demonstrate by drawing, how chromosomal mutations may occur by

- (i) inversion: (Use ONE chromosome)

TABLE A

Diagram of how it occurs	Diagram of the result

- (ii) duplication: (Use TWO chromosomes)

TABLE B

Diagram of how it occurs	Diagram of the result

[4 marks]

- (b) (i) Define the term 'gene mutation'.

[1 mark]

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- (b) (ii) Plant species A has SEVEN chromosomes in its gametes. Plant species B has NINE chromosomes in its gametes. When Plant A was crossed with Plant B the hybrids produced were sterile. A microscope observation of their pollen mother cells showed no chromosome pairing. A section from one of the hybrids that grew vigorously was propagated vegetatively, producing a Plant with 32 chromosomes in its somatic cells. This plant was fertile.

a) Suggest why the hybrids were sterile.

[1 mark]

b) Why was Plant C fertile?

[1 mark]

- (c) Colchicine is an alkaloid that inhibits spindle formation. Deduce the effect the compound would have on cells undergoing mitosis.

[1 mark]

- (d) Distinguish between autopolyploidy and allopolyploidy.

[2 marks]

Total 10 marks

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9. (a) The Hibiscus is an Angiosperm. Like all Dicotyledons it has broad leaves. It belongs to the family Malvaceae, which in turn belongs to the Malvales. There are a number of other hibiscus-like plants, as shown in Table 1.

TABLE 1
MEMBERS OF THE MALVACEAE

	Botanical name	Description
Hibiscus	H. rosa-sinensis	A shrub with red flowers
Okra	H. esculentus	A herbaceous plant with yellow flowers and long green edible fruit
Sorrel	H. sabdarifa	A shrubby plant with yellow flowers The calyx is red and full of juice
Blue Mahoe	H. elatus	A tree with yellow flowers which turn red-brown by afternoon
Sea Island Cotton	Gossypium sp	A shrub with yellow flowers which produces a capsule containing seeds embedded in fluffy cotton fibres

Using the features in Table 1 create a set of dichotomous keys to distinguish between members of the Malvaceae.

[4 marks]

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- (b) Classification of organisms is based on a hierarchy composed of levels of specialization called taxa. Table 2 lists the taxonomic levels. Alongside each taxon, write the appropriate name, derived from the data in (a), for the okra.

TABLE 2
TAXONOMIC LEVELS

Taxonomic level	Example
Kingdom	_____
Phylum	_____
Class	_____
Order	_____
Family	_____
Genus	_____
Species	_____

[3 marks]

- (c) The FIVE Kingdom classification system is used to categorize living organisms. Name THREE of these Kingdoms and for each, give ONE distinguishing feature.

[3 marks]

Total 10 marks

END OF TEST

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