Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Promotional Examination
Year 5

H2 BIOLOGY — 9744/02

Paper 2 Section A (Structured Questions) — **27 September 2022**

Paper 2 Section B (Long Structured and Free-Response Questions) — **1 hour 30 minutes**

READ THESE INSTRUCTIONS FIRST:

Write your class, index number and name at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Sections A and B

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Paper 1	
MCQ	15
Paper 2	
Section A	
1	6
2	10
3	9
4	10
Section B	
1	15
2	15
Total	80

This document consists of **15** printed pages and **3** blank pages.

Section A: Structured Questions

Answer **all** questions.

Question 1

Fig 1 shows a part of the collagen synthesis pathway at the rough endoplasmic reticulum.

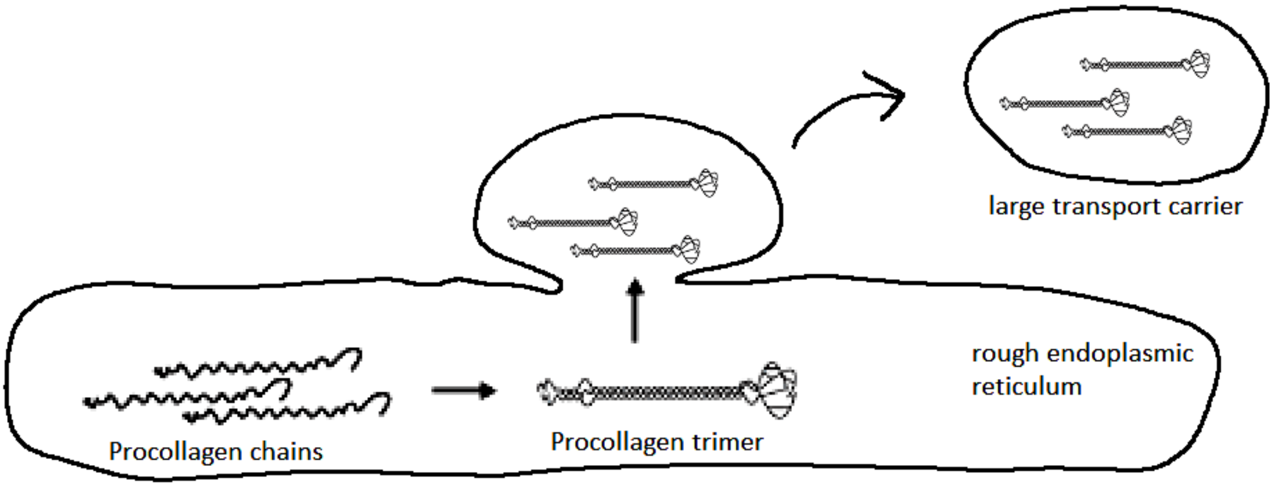

Fig 1

With reference to Fig 1,

(a) **(i)** name the most common amino acid in procollagen chain,

.... [1]

(ii) name the bond that stabilises the procollagen trimer,

.... [1]

(b) describe how collagen fibrils are synthesized outside the cell from procollagen trimers.

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.... [4]

Total: [6]

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Question 2

Polygalacturonase (PG) plays an important role in fruit softening by making the pectin of the cell wall more soluble.

In order to slow down the ripening of tomatoes, antisense RNA technology was used where a second copy of the gene was inserted into the tomato genome in the antisense direction (transformed fruit). *PG* antisense RNA has a sequence which is complementary to *PG* mRNA. When the gene coding for antisense RNA is expressed, it interferes with the production of the PG, delaying the ripening process.

mRNA extracted from ripe and unripe untransformed and transformed fruits were hybridised to radioactively labelled probes specific to the *PG* sense strand. Fig 2 shows the results expressed as the percentage of *PG* mRNA in ripe untransformed fruit.

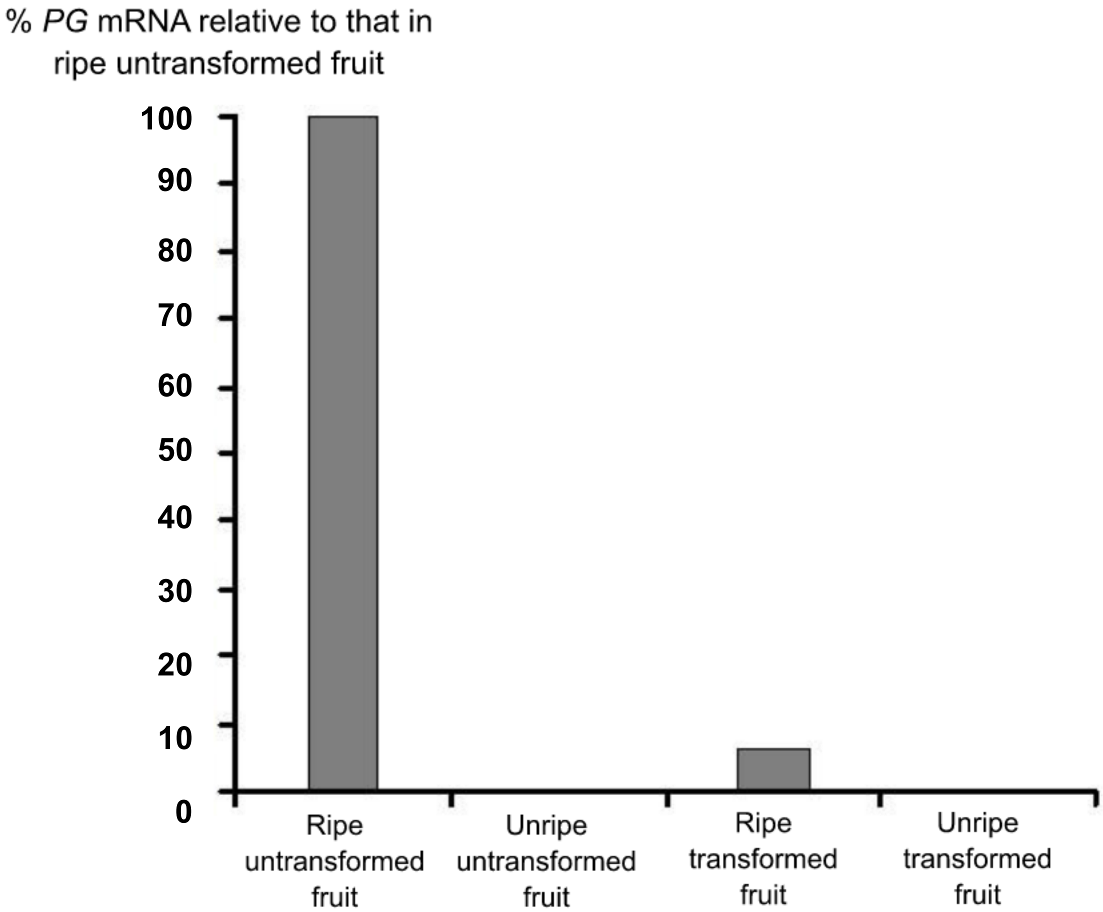

Fig 2

(a) Contrast the process of the synthesis of *PG* mRNA and the synthesis of PG in a cell.

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.... [4]

(b) Explain how the antisense RNA technology affects ripe transformed fruits.

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.... [4]

(c) PGs can also be produced by pathogens to degrade plant cell walls and invade tissues. In plant defense, polygalacturonase-inhibiting proteins (PGIPs) are produced in cell walls to inhibit the activity of such PGs.

Upon an infection, it was observed that

- the same plant exhibits different degrees of susceptibility to different pathogenic PGs.
- different plants also exhibit different degrees of susceptibility to the same pathogenic PGs.

The different cell wall compositions in different plants might explain the different degrees of susceptibility observed.

Suggest other reasons for the differing degrees of susceptibility observed.

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.... [2]

Total: [10]

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Question 3

Fig 3.1 shows the function of permease in the cell surface membrane of *E. coli*.

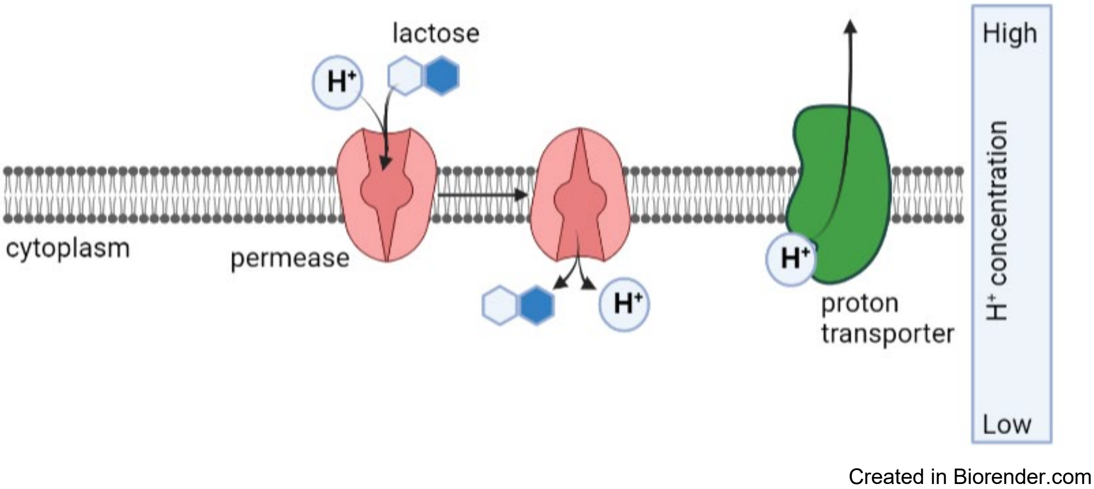

Fig 3.1

(a) With reference to Fig 3.1, describe the function of permease.

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.... [2]

(b) Permease is encoded by the *lacY* gene of *lac* operon.

Explain how an increase in lactose concentration changes the amount of permease in the cell surface membrane of *E. coli*.

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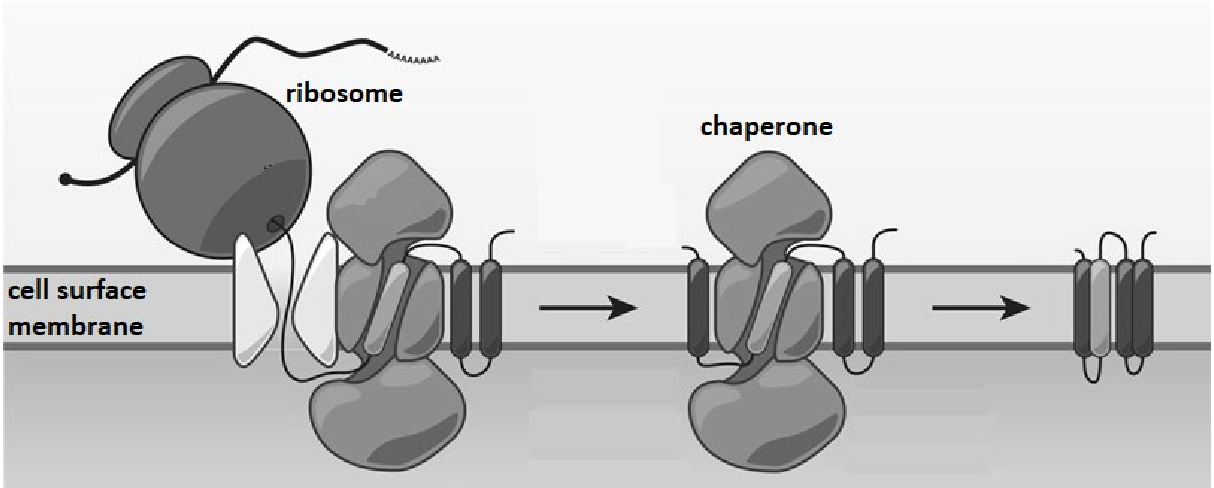
.... [5]

(c) Folding of polypeptides in a cell typically requires the assistance of molecular chaperones, a class of protein complexes.

Fig 3.2 shows the chaperone complex that assists the folding of polypeptide into permease.



Edited from Matthew J Shurtleff (2018).

Fig 3.2

Suggest why this chaperone is embedded within the membrane.

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.... [2]

Total: [9]

Question 4

The mitotic cell cycle in the somatic cells of a diploid organism can be followed by measuring the number of chromosomes and the amount of DNA material per cell over a period of time. Fig 4 shows the results of the analysis, beginning with the start of mitosis.

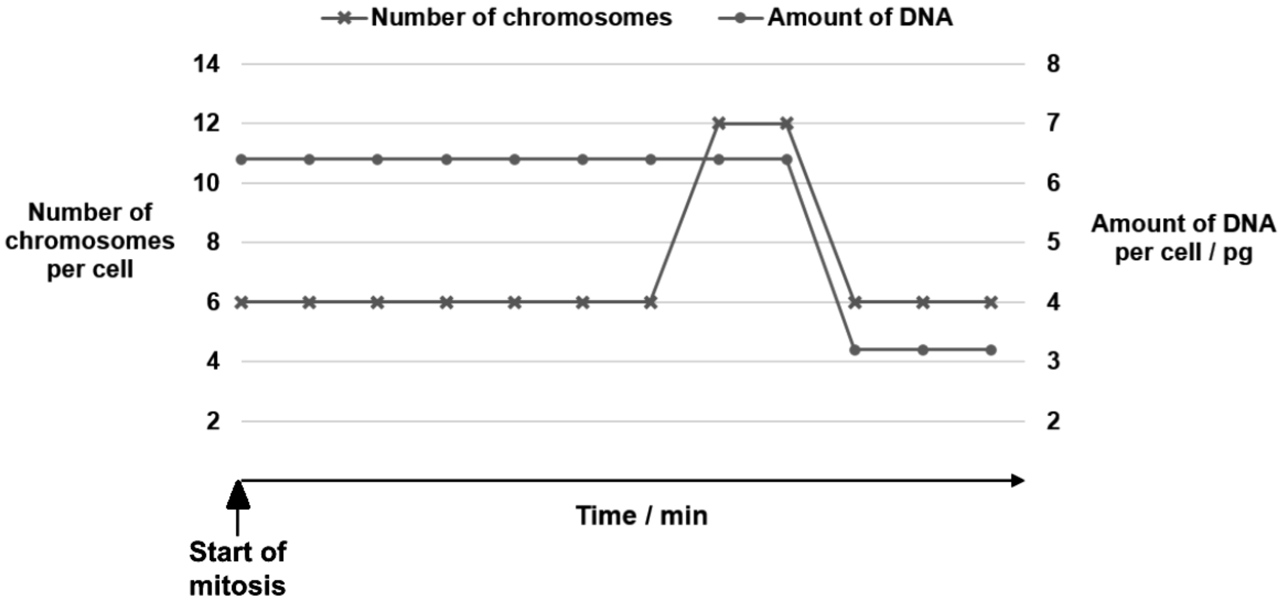

Fig 4

(a) **(i)** On Fig 4, indicate with an arrow (↑) where anaphase begins. [1]

(ii) Explain your answer in **(a)(i)**.

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.... [3]

(iii) A germ cell of this organism undergoes meiosis to give rise to gametes.

Explain how the results of the analysis will differ in a gamete of this organism.

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.... [3]

(b) Explain how meiosis leads to genetic variation in gametes.

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.... [3]

Total: [10]

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Name:		Index Number:		Class:	

Section B: Long Structured and Free-Response Questions

Answer **all** questions.

Question 1

(a) DNA methylation is the transfer of a methyl group ($-CH_3$) onto the C5 position of the cytosine to form 5-methylcytosine. It is a form of chemical modification different from protein chemical modification.

Describe one difference between the two forms of chemical modification in eukaryotes.

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.... [1]

(b) Explain the role of DNA methylation in eukaryotes.

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.... [4]

(c) Some mothers of infants with Down syndrome have a single base pair substitution in the gene *DNA (cytosine-5)-methyltransferase 3B (DNMT3B)*, which codes for a type of DNA methyltransferase. The mutation resulted in the lack of methyl groups on centromeric DNA, leading to mistakes in the segregation of chromosomes during meiosis.

Suggest how a lack of methyl groups on the centromeric DNA resulted in infants with Down syndrome.

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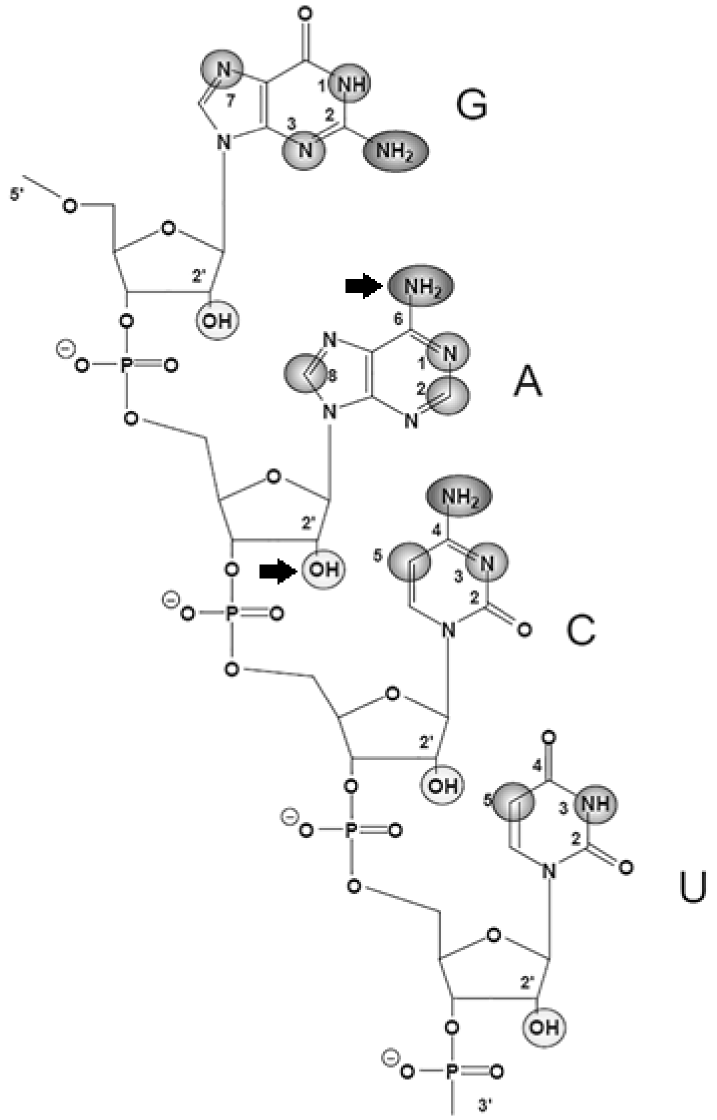
.... [3]

(d) Besides DNA methylation, RNA can also be methylated. Fig 1.1 shows all the known RNA methylation sites that are circled.



Edited from Yuri Motorin & Mark Helm (2021). WIREs RNA, Volume: 13, Issue: 1.

Fig 1.1

Recent studies found that *N6,2'-O-dimethyladenosine* (m6Am) is the most prevalent modified base at the 5' end of an mRNA, at the first encoded nucleotide adjacent to the 7-methylguanosine cap. The two sites methylated in m6Am are indicated with an arrow (➡) in Fig 1.1.

(i) Describe the functions of the 7-methylguanosine cap.

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.... [2]

(ii) Suggest a role for m6Am adjacent to 7-methylguanosine cap at the 5' end of an mRNA.

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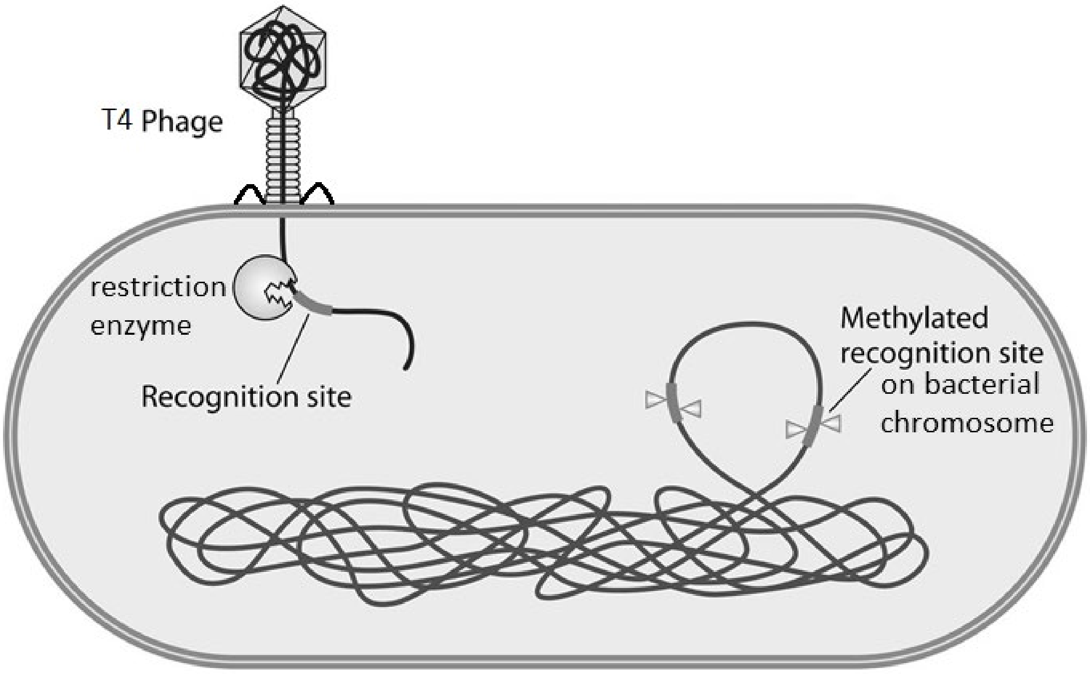
.... [1]

(e) DNA methylation also plays a significant role in prokaryotes, such as protection against restriction enzyme digestion. Restriction enzymes are endonucleases synthesized by prokaryotes. Fig 1.2 shows the normal function of restriction enzymes in prokaryotes.



Edited from K.Vasu & V. Nagaraja (2013)

Fig 1.2

With reference to Fig 1.2, predict and explain what happens to the prokaryotic cell in the absence of the restriction enzyme.

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.... [4]

Total: [15]

Write your answers in the Answer Booklet provided.
Your answers should be illustrated by large, clearly labelled diagrams, wherever appropriate.

Your answer must be in continuous prose, where appropriate.

2 Describe how the genome of influenza and HIV are replicated within their host cells and explain why the end replication problem does not exist in both cases. [15]

Total: [15]