TEMASEK JUNIOR COLLEGE
PROMOTIONAL EXAMS 2023
Higher 2

CANDIDATE NAME	

CIVICS GROUP			/	2	3

BIOLOGY
SECTION B [PART I]
STRUCTURED QUESTIONS

9744
FRIDAY, 22 SEPTEMBER 2023
2 hours 40 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

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 any 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	
Section A	**/ 20**
Section B	
1	**/ 11**
2	**/ 12**
3	**/ 14**
4	**/ 23**
Section C	
Essay	**/ 25**
Total	**/ 105**

Answer **all** questions

1 (a) Fig. 1.1 shows the behaviour of eight chromosomes in one stage of meiosis of a diploid plant cell.

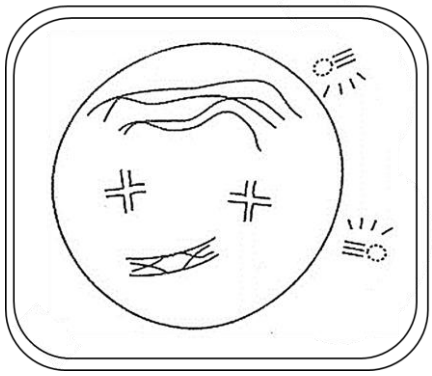

Fig. 1.1

(i) Name the stage of the nuclear division.

…… [1]

(ii) Based on the observation of the chromosomes in Fig. 1.1, explain why it **cannot** be a stage in mitosis.

……..

…… [1]

(iii) The diploid number of the flowering plant is 8. Complete Table 1.1 to show the number of chromosomes found in the cell at the end of each stage of the meiotic cell cycle.

Table 1.1

stage	no. of chromosomes per cell
G1	8
S phase	
Anaphase I	
Telophase I	
Cytokinesis I	4
Cytokinesis II	

[2]

(iv) With reference to Table 1.1, explain the change in the number of chromosomes per cell by the end of cytokinesis I.

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……..

…… [1]

Fig. 2.1 shows the change in the amount of DNA per nucleus during a meiotic cell cycle.

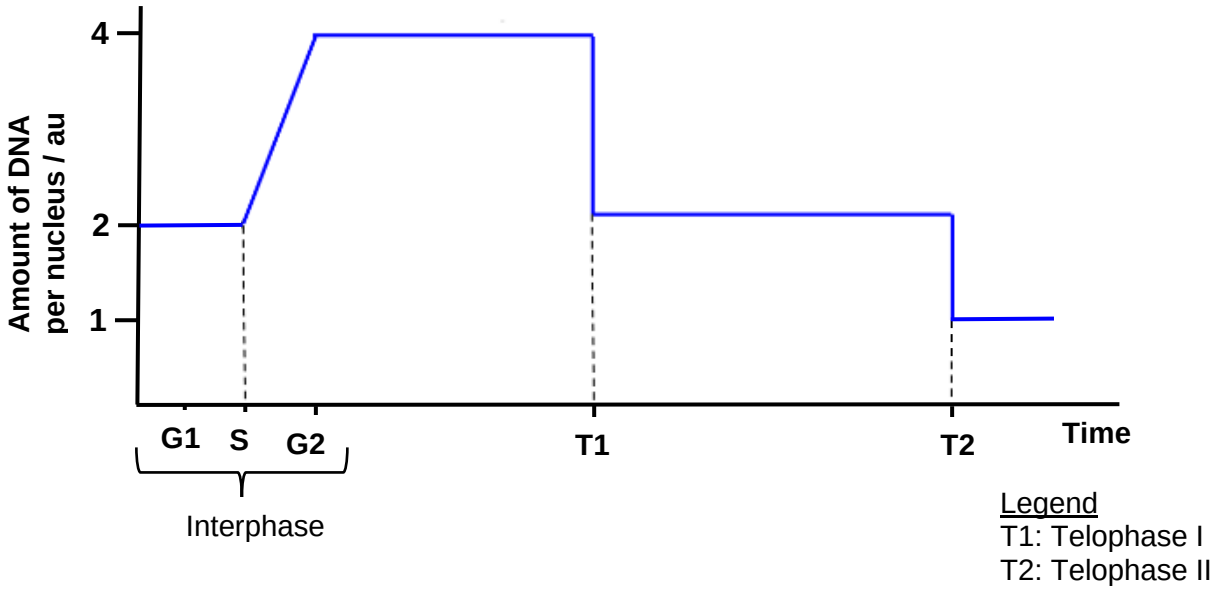

Fig. 1.2

(b) With reference to Fig. 1.2, account for the changes in amount of DNA per nucleus from the start of the cell cycle to the end of meiosis I.

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…… [2]

(c) Describe **one** difference between a pair of homologous chromosomes and sister chromatids of a chromosome.

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…… [1]

(d) State the challenges of using embryonic stem (ES) cells for research or medical treatment and explain how induced pluripotent stem cells (iPSCs) may overcome each of these challenges.

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…… [3]

[Total: 11]

2 (a) Fig. 2.1 shows the relationship between CO_2 assimilation rate and increasing light intensity in a plant, when carbon dioxide concentration is not a limiting factor.

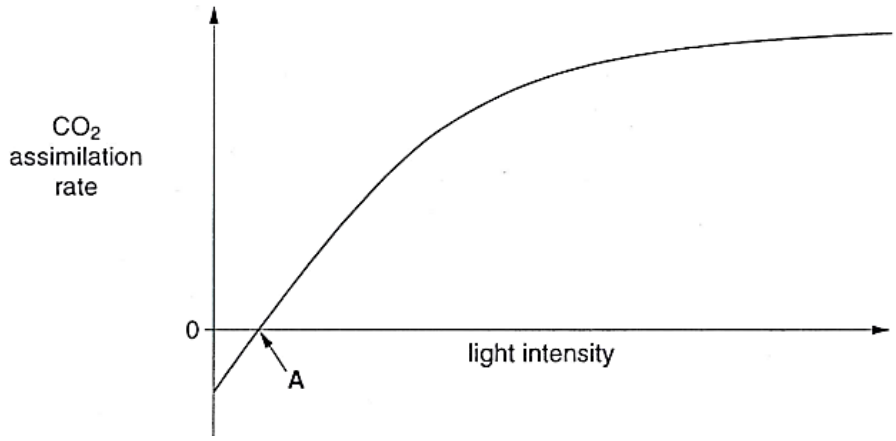

Fig. 2.1

(i) Explain why the CO_2 assimilation rate levels off at high intensity.

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…… [2]

(ii) Explain why the CO_2 assimilation rate is negative at the lowest light intensity.

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…… [2]

(iii) Describe the significance of point **A** to the growth of the plant.

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…… [2]

(b) The conditions in which young plants are grown affects their ability to photosynthesise at high and low temperatures when they are mature.

Young maize and wheat plants were grown to maturity at high and low temperatures. When they were mature, their rate of photosynthesis was measured at different temperatures.

The results are shown in Fig. 2.2.

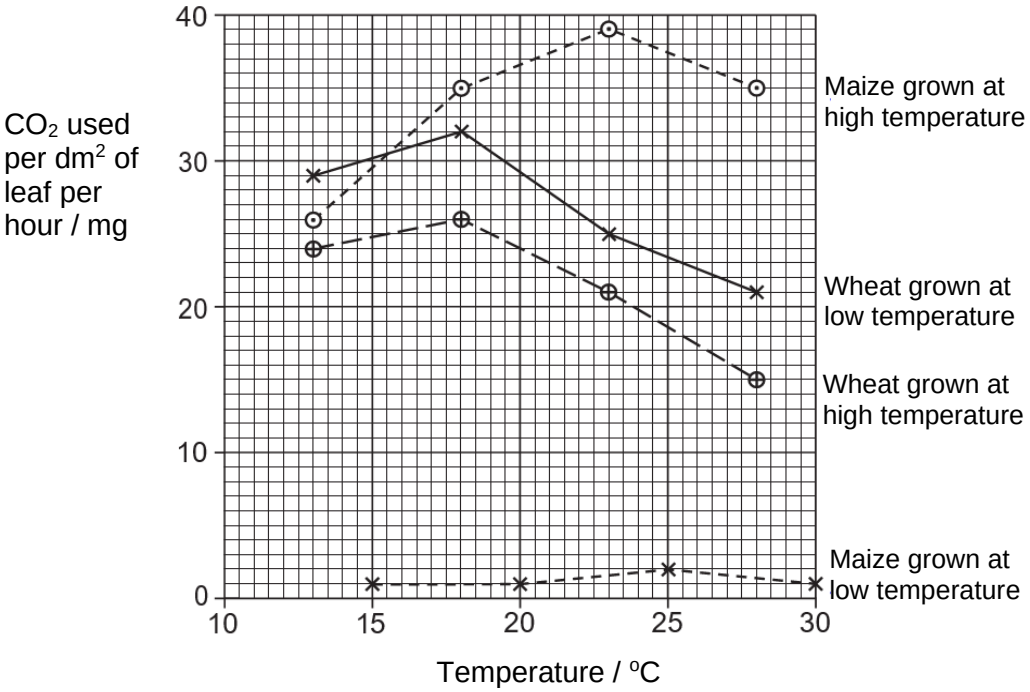

Fig. 2.2

(i) With reference to Fig. 2.2, compare **one** effect of temperature on the rate of photosynthesis of maize plants and wheat plants that were grown at high temperature.

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……

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……

…… [2]

(ii) It was observed that low temperatures reduced the formation of the thylakoid membranes inside the chloroplasts of maize leaves, but not in wheat leaves.

Using this information and the results in Fig. 2.2, suggest a possible reason for the different results for maize and wheat grown at low temperatures.

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…… [2]

(c) Describe **two** differences between Calvin cycle and Krebs cycle.

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…… [2]

[Total: 12]

DO NOT WRITE IN THIS MARGIN

End of Section B Part I

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TEMASEK JUNIOR COLLEGE
PROMOTIONAL EXAMS 2023
Higher 2

CANDIDATE NAME	
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BIOLOGY 9744
SECTION B [PART II]
FRIDAY, 22 SEPTEMBER 2023
STRUCTURED QUESTIONS
2 hours 40 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

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For Examiner's Use	
Section B (Part II)	
3	**/ 14**
4	**/ 23**

This document consists of **8** printed pages.

Answer **all** questions**.**

3 The *lac* operon is a section of DNA present in the genome of *Escherichia coli*. The structural genes of the *lac* operon are only fully expressed when the bacteria are exposed to certain conditions.

Fig. 3.1 is a diagram showing the *lac* operon and a nearby region of the *E. coli* genome.

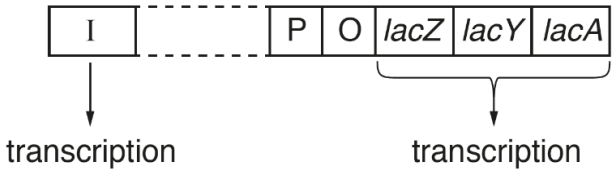

Fig. 3.1

(a) Fig. 3.1 shows how the *lac* operon consists of structural genes and regulatory sequences.

(i) Using Fig. 3.1, identify **two** additional structural genes on the *lac* operon, and complete Table 3.1 to name each structural gene and its product. One example has been shown for you.

Table 3.1

structural gene	**name of gene product**
*lac*Y	*lac* permease

[2]

(ii) Gene ***I*** is transcribed all the time to produce its protein. This is known as constitutive expression.

Explain why some genes show constitutive expression.

……

……

…… [1]

(iii) The product of gene ***I*** has a unique structure that is tied to its specific function on the *lac* operon.

Describe how the product of gene ***I*** binds to region O of the *lac* operon.

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…… [2]

(b) When the *E.coli* are exposed to certain conditions, the *lac* operon will synthesise some enzymes. These are described as inducible enzymes.

(i) Explain what is meant by an *inducible enzyme*.

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…… [2]

(ii) Apart from the presence/absence of lactose, the levels of glucose present in the external environment also affects the expression of the *lac* operon.

Explain how low levels of glucose affect the expression of the *lac* operon.

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…… [3]

(iii) The unphosphorylated form of a protein, $EIIA^{GLC}$, is able to interact with *lac* permease and inactivate it.

Suggest the effect of $EIIA^{GLC}$ on the expression of the *lac* operon even when lactose is present in the external environment.

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…… [2]

(c) The prokaryotic genome is different from the eukaryotic genome in many different ways.

With reference to structural organization, state **two** differences between the prokaryote and eukaryote genome, other than the presence of operons.

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…… [2]

[Total: 14]

4 A diagram of a chromosome from a dividing cell is shown in Fig. 4.1.

Fig. 4.1

(a) Before a cell divides, DNA replication takes place via semi-conservative replication.

State **two** ways how DNA replication differs from transcription.

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……

……

……

…… [2]

(b) A dividing cell is at risk of losing genetic material each time DNA replication occurs.

(i) On Fig. 4.1, add a label line and the letter G to show the location on the chromosome of an area that helps to prevent the loss of genes. [1]

(ii) Briefly describe one other function of this region of the chromosome.

……

……

…… [1]

(c) The chromosome shown in Fig. 4.1 consists of one long DNA molecule associated with histone proteins.

Name one stage of mitosis in which a chromosome would have the same general structure as the chromosome shown in Fig. 4.1.

…… [1]

(d) Name the stage in the cell cycle during which the cell divides to produce two genetically identical daughter cells.

…… [1]

The enzyme telomerase ensures that telomeres do not shorten after DNA is replicated.

Fig. 4.2 shows a specific region of a DNA molecule during replication. DNA polymerase cannot attach to the region labelled X, so it cannot complete the synthesis of the new strand without the action of telomerase.

Telomerase synthesises additional lengths of DNA that are added to the telomere. These additional lengths are used by DNA polymerase to complete the process of replication.

Fig. 4.3 is an enlarged view of region X to show the action of the enzyme telomerase.

Fig. 4.2

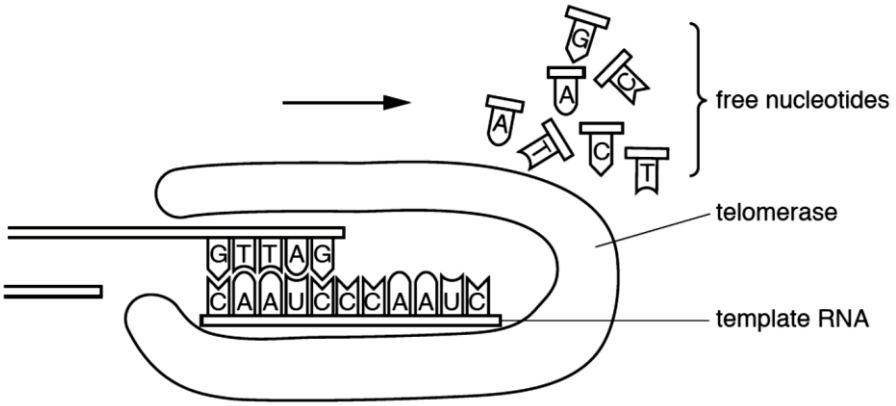

Fig. 4.3

(e) With reference to Fig. 4.2 and Fig. 4.3, explain how a molecule of telomerase synthesizes additional lengths of DNA.

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…… [4]

(f) Telomerase is not present in prokaryotic cells.

Suggest why prokaryotes do **not** have telomerase.

…… [1]

(g) Lung cancer can be caused by carcinogens. Benzopyrene, a compound found in tar from tobacco smoke is known to interfere with DNA replication.

It brings about gene mutation via transversion mutation or transition mutation. Both cause the newly synthesised strand to have an incorrect base.

(i) A transversion mutation is when a pyrimidine is used in the newly synthesised strand instead of a purine, or the other way round.

Name the **two** possible bases that could be used instead of cytosine in a transversion mutation.

…… [1]

(ii) A transition mutation is when a purine is replaced by an incorrect purine or a pyrimidine is replaced by an incorrect pyrimidine.

Suggest why transversion mutations are less likely to occur than transition mutations.

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…… [2]

(iii) It has been observed that the carcinogens in cigarette smoke can also cause the deletion of a nucleotide base from the promoter of a gene.

State the role of the promoter in a gene.

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…… [1]

(iv) The methylation of tumour suppressor genes can cause loss of function mutation driving a cell to become cancerous.

Describe how the promoter of tumour suppressor genes becomes methylated.

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…… [2]

The process of protein synthesis takes place in both cancerous and non-cancerous cells. Many types of nucleic acids are involved in the process.

(h) State **one** way in which the structure of DNA differs from the structure of messenger RNA.

……..…..…… [1]

(i) At the start of translation, amino acid activation takes place whereby an amino acid attaches to its specific tRNA molecule. This process requires an enzyme, aminoacyl tRNA synthetase.

Explain why a particular amino acid needs to be linked to a specific tRNA molecule.

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……..…..…… [2]

(j) Ribosomes are required for protein synthesis.

State **two** functions of ribosomes in protein synthesis.

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……..…..…… [2]

(k) Suggest **one** possible effect of gene mutation in the cell during the synthesis of proteins.

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……..…..…… [1]

[Total: 23]

End of Section B Part II

TEMASEK JUNIOR COLLEGE
PROMOTIONAL EXAMS 2023
Higher 2

CANDIDATE NAME	

CIVICS GROUP			/	2	3

BIOLOGY 9744
SECTION C
FRIDAY, 22 SEPTEMBER 2023
Free-Response Question
2 hours 40 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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You may use an HB pencil for any diagrams or graphs.
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Answer **one** question in the spaces provided on the Question Paper.

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You may lose marks if you do not show any 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.

Circle the essay question that you have selected in the box below.

For Examiner's Use	
Section C	
Essay* **5 / 6** **circle*	**/ 25**

Section C

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in parts **(a)** and **(b)**, as indicated in the question.

5 **(a)** Describe the process of oxidative phosphorylation and state ways it is different from photophosphorylation [13]

(b) With named examples, describe the different roles of proteins in the eukaryotic cell. [12]

[Total: 25]

6 DNA is a hereditary material which contains thousands of genes which code for proteins that control cell function. DNA must be replicated and passed to daughter cells.

(a) Describe the process of DNA replication. [12]

(b) Describe how ribonucleic acids are involved in the flow of information from DNA to proteins. [13]

[Total: 25]

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End of Section C