

Civics Group	Index Number	Name (use BLOCK LETTERS)
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**H2**



**ST. ANDREW'S JUNIOR COLLEGE  
2025 JC2 PRELIMINARY EXAMINATIONS**

**H2 BIOLOGY**

**9744/03**

**Paper 3**

Wednesday

17<sup>th</sup> September 2025

2 hours

**READ THESE INSTRUCTIONS FIRST**

Write your name, civics group and index number on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagram, graph or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

All working for numerical answers must be shown.

Conceptual error (C)	Data Quoting (D)	Expression (E)	Misreading the question (Q)

For Examiners' Use	
1	/30
2	/12
3	/8
4 or 5	/25
<b>Total</b>	<b>/75</b>

This document (Booklet A) consists of **18** printed pages.

**[Turn over]**

Answer all questions.

## QUESTION 1

Control of processes in cells must be heavily regulated, failure which results in diseases. Circadian rhythm, the body's internal clock that regulates sleep and wake cycle over a 24-hour period, is one such process. It synchronizes body cells with external cues like light and darkness to influence sleep-wake cycles, hormone release and body temperature

Clock proteins CLK, BMAL1, PER and CRY are essential proteins that help regulate the circadian rhythm. Proteins CLK and BMAL1 form a complex, which acts like transcriptional activators.

Fig. 1.1 shows how these proteins, encoded by "clock genes", oscillate in control of the circadian rhythm.

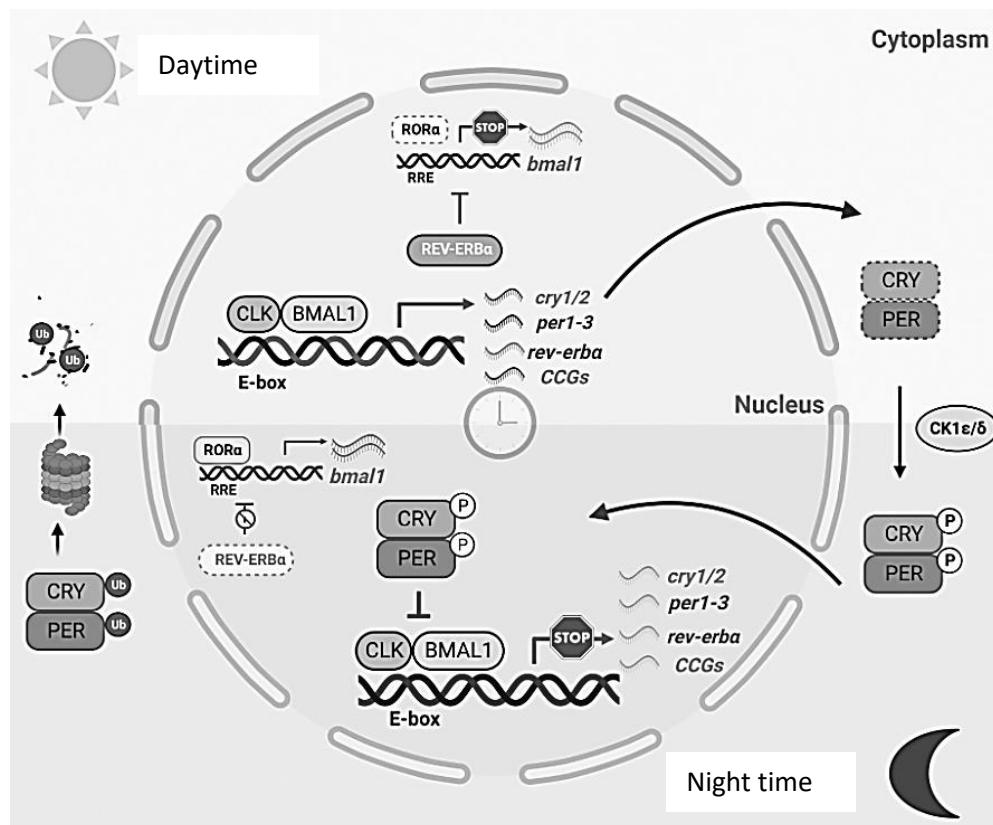


Fig. 1.1

- (a) With reference to Fig. 1.1, state and explain the level at which the CRY and PER proteins are regulated during the **night** to establish the circadian rhythm.

Level of regulation:

.....

Explain:

.....  
 .....  
 .....  
 .....  
 .....[3]

- (b) A dysregulation of the circadian rhythm leads to various effects on the body, for example, the feeling of jetlag, where the body's core biological processes are "out of sync" with the new environment.

Light exposure helps to reset the circadian rhythm by influencing the transcription of PER and CRY through melanopsin signaling. Melanopsin is a light-sensitive photoreceptor.

Fig. 1.2 shows the cell signaling process involving melanopsin.

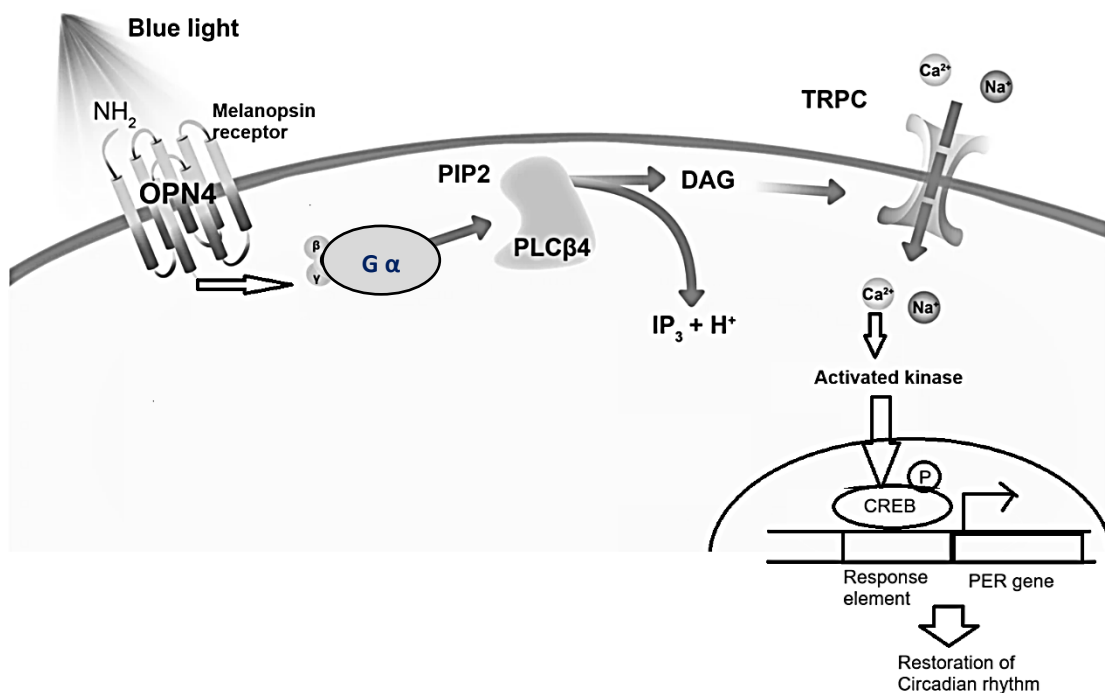


Fig. 1.2

(i) identify the type of receptor for melanopsin.

..... [1]

(ii) describe how the shining of light on the receptor leads to restoration of the circadian rhythm.

[6]

**(c)** The dysregulation of PER2 gene may be associated with cancer.

Fig. 1.3 shows the data of PER2 gene expression against different parameters.

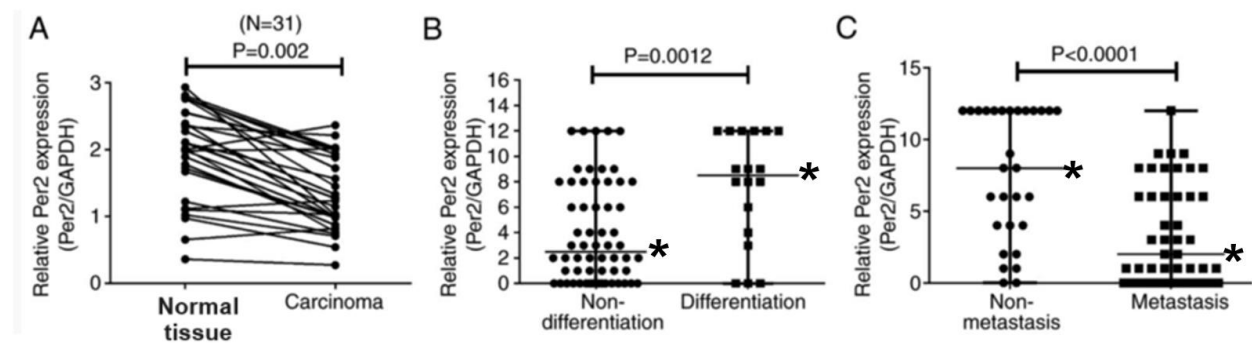


Fig B and C: Asterisk \* represents the median

Fig. 1.3

PER2 expression levels in normal and cancerous tissues are analysed by reverse transcription-quantitative polymerase chain reaction. Reverse transcription-quantitative polymerase chain reaction is primarily used to measure the amount of a specific mRNA molecule in a sample over time.

(i) With reference to the trends from Fig. 1.3, explain if PER2 gene promotes or inhibits progression of cancer. (No quoting of numerical data is required).

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.....[3]

(ii) Suggest why reverse transcription-quantitative polymerase chain reaction is used instead of the standard polymerase chain reaction to study gene expression.

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.....[2]

(iii) GAPDH (Glyceraldehyde-3-phosphate dehydrogenase) is a "housekeeping" protein, being expressed commonly in all cells and tissues at relatively high levels. GAPDH is usually analysed together with PER2 expression in Fig.1.3.

Suggest why.

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.....[1]

- (d) Mutations to proto-oncogenes are also crucial in cancer development. One example is the ras protein.

Fig.1.4 shows the Western blot analyses of ras protein in normal tissues and a cancerous tissue.

A western blot measures the presence, amount, and sometimes size of specific proteins within a sample

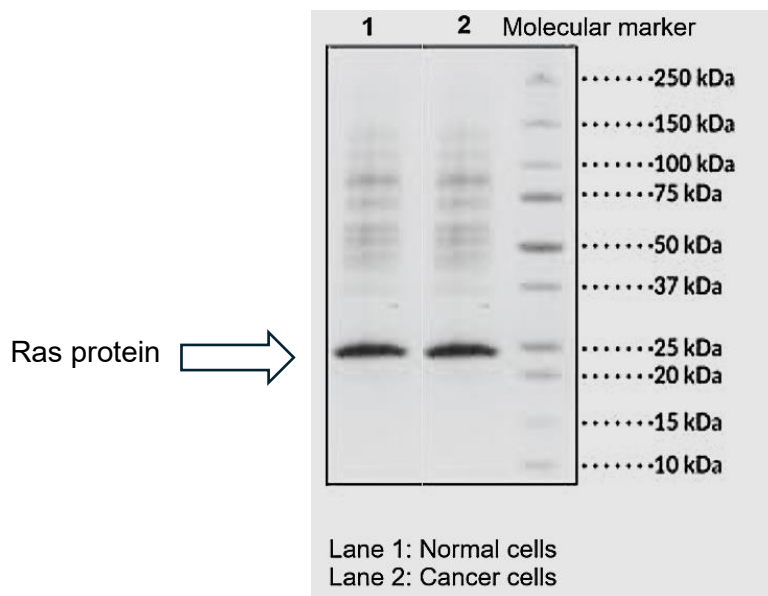


Fig. 1.4

- (i) With reference to Fig. 1.4, tick against the appropriate the method(s) of conversion of ras to an oncogene.

Method of conversion to oncogene	Tick if appropriate (✓)
Point mutation to the <i>ras</i> gene	
Insertion of a more active viral promoter ahead of the <i>ras</i> gene	

[1]

- (ii) Explain your choice(s) in (d)(i) and describe how this/these method(s) promote(s) cancer.

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.....[3]

- (e) While cancer is a leading cause of death, cardiovascular diseases, including heart conditions, are also major causes of death.

Angiotensin converting enzyme (ACE) inhibitors are a class of medications primarily used to treat high blood pressure and heart failure. They work by blocking the enzyme that converts angiotensin I to angiotensin II, a substance that narrows blood vessels. By reducing the amount of angiotensin II in the body, ACE inhibitors help relax blood vessels, lower blood pressure, and reduce the workload on the heart.

Fig. 1.5 shows the structures of the real substrate and some proposed inhibitors for ACE.

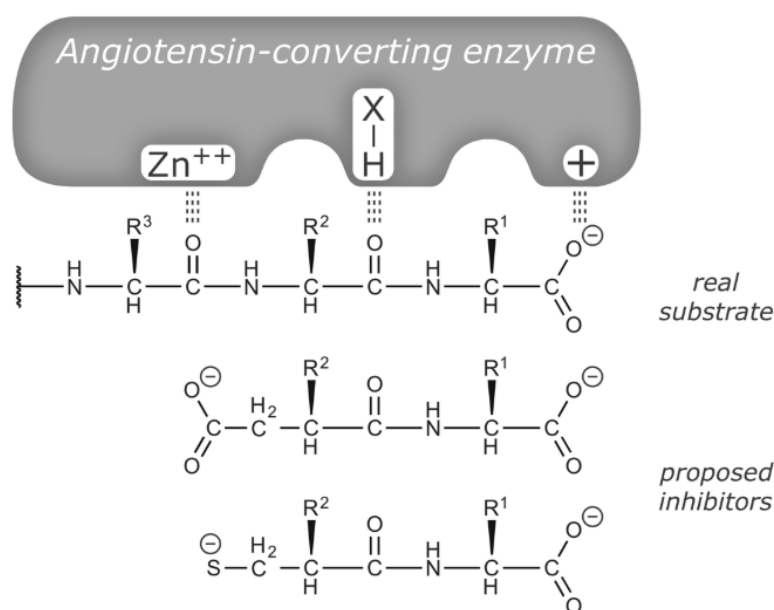


Fig. 1.5

- (i) Describe the mode of enzyme inhibition based on the structures of the inhibitors shown in Fig. 1.5

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.....[3]  
 (ii) Describe the effect of high substrate concentrations on these kind of inhibitors.

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(iii) Suggest why the same active site can accommodate more than one molecule of slightly differing shapes.

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.....[1]

(iv) Enzyme inhibitors such as penicillin are commonly used as antibiotics against bacteria. Contrast between the actions of ACE inhibitors in (e)(i) and penicillin.

ACE inhibitors	Penicillin

[3]

[Total: 30]



**QUESTION 2**

Melting permafrost in Siberia has revealed a well-preserved rhinoceros, with many of its internal organs still intact. Due to warming of the region, the permafrost is thawing, particularly during the summer months.

The rhinoceros remains were discovered not far from where Sasha, the world's only baby woolly rhinoceros ever found, was discovered in 2014. Sasha has been carbon-dated to be 34,000 years old and help proved that woolly rhinoceroses were covered in thick hair. Similarly the newly revealed rhinoceros is also described as having a "very thick short underfur".

- (a)** Suggest how melting of the permafrost containing frozen organic matter could further contribute to climate change.

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..... [2]

- (b)** While both the newly found rhinoceros and Sasha are observed to have thick hair, this morphological trait may be insufficient to prove that they have a closely related evolutionary relationship

Explain how molecular homology could be used to support this hypothesis.

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..... [2]

- (c)** Explain two advantages of using molecular methods in classifying organisms compared to using similarities in morphology.

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..... [2]

The woolly rhinoceros is currently extinct.

Among the five extant rhinoceros species today, the Javan rhinoceros (*Rhinoceros sondaicus*) is the rarest, consisting of a single population in Ujung Kulon National Park (UKNP) on the western tip of the Indonesian island of Java.

Both fossil and genetic analyses indicate that the Indian rhinoceros (*Rhinoceros unicornis*) is the closest extant relative of the Javan rhinoceros.

The Indian rhinoceros is primarily found in northeastern India and Nepal, while the Javan rhinoceros is primarily present in Java, Indonesia (Fig. 1).



Figure 1: Map showing the geographical proximity of India and Indonesia

(d) Explain how evolution results in the speciation of the Javan rhinoceros and the Indian rhinoceros from their common ancestor.

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[Total: 12]

### QUESTION 3

Corals are affected by climate change.

Fig. 3.1 shows the percentage and predicted percentage of coral bleaching over time.

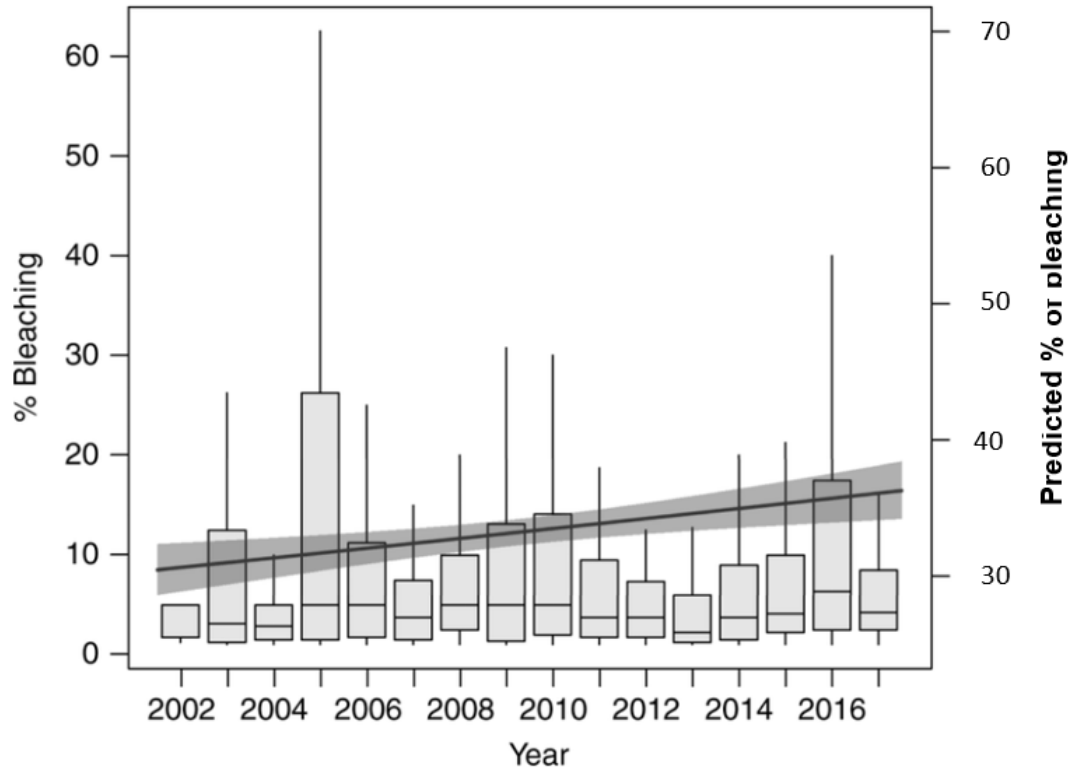
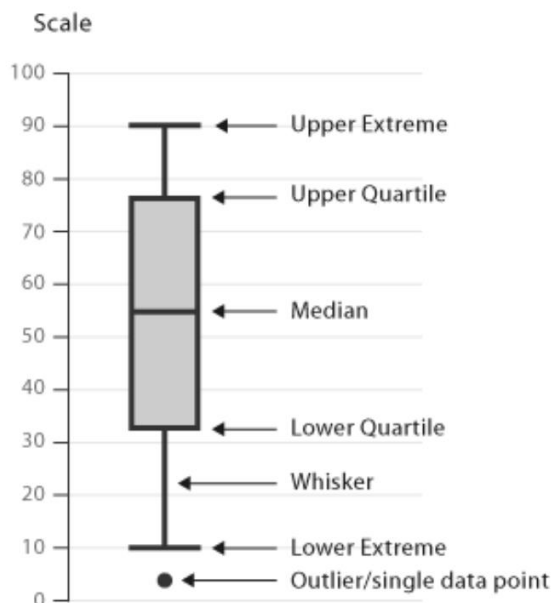


Fig. 3.1

Percentage of coral bleaching and predicted percentage of coral bleaching measured at 3351 sites in 81 countries, from 2002 to 2017. The linear line is the predicted percentage of coral bleaching over time, measured on the right y axis, and the shaded region is the 95% confidence interval.



The boxplots are of the percentage coral bleaching, which is measured on the left y axis. The center line of the boxplot is the median percentage bleaching, the bounds of the boxes are the interquartile range (25 and 75). The “whiskers” extend from the ends of the box to the smallest and largest data values.

- (a) With reference to Fig. 3.1, describe the **predicted percentage** of coral bleaching from 2002 to 2017.

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 ..... [1]

- (b) With reference to Fig. 3.1, comment whether the prediction of bleaching is valid.

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 .....  
 .....  
 ..... [2]

- (c) Explain two factors resulting from climate change, that could contribute to the death of corals.

Factor 1:

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Factor 2:

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[5]

**[Total: 8]**

### Essay

Answer **one** question only in this section.

Write your answers on the lined paper provided at the end of this question paper. Indicate the choice of question clearly on your answer.

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 sections (a), (b) etc., as indicated in the question.

- |          |   |
|----------|---|
| <b>4</b> | <p><b>(a)</b> Describe and explain how the structure of collagen is related to its function. [10]</p> <p><b>(b)</b> Explain the importance of receptors in cell processes. [15]</p> |
| <b>5</b> | <p><b>(a)</b> Describe and explain how the structure of glycogen is related to its function. [10]</p> <p><b>(b)</b> Explain the importance of hydrogen bonds in the cell. [15]</p>  |

**[Total: 25]**

**Response to Essay:**

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[illegible]

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[illegible]

[illegible]

This image shows a full page of primary-ruled paper. It features approximately 20 horizontal dashed lines spaced evenly down the page, providing a guide for handwriting practice. The background is white, and there are no margins or other markings present.

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**-End of Paper-**