

NATIONAL JUNIOR COLLEGE, SINGAPORE
Senior High 2
Preliminary Examinations
Higher 2

CANDIDATE
NAME

BIOLOGY
CLASS

REGISTRATION
NUMBER

Biology

9744/03

Paper 3

3 September 2019

Additional Materials: Answer Booklet

2 hours

READ THESE INSTRUCTIONS FIRST

Write your name and Biology class 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 diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** parts of the question in the spaces provided on the Question Booklet.

Section B

Answer **both** parts of the question in the spaces provided on the Answer Booklet.

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

At the end of the examination, fasten all your work securely together.
The number of marks is given in the brackets [] at the end of each question or part of question.

For Examiner's Use	
Section A	
1	/30
2	/8
3	/12
Section B	
4/5	/25
Total	/75

This document consists of **14** printed pages.

Section A

Answer **all** the questions in this section.

- 1 (a) Cyclin-dependent kinases (CDKs) are important cell-cycle regulators. To study them, the gene can be amplified using polymerase chain reaction (PCR), and the fragments ligated into cloning vectors.

PCR was used to amplify the CDK coding sequence using the following primers, which were designed to incorporate restriction sites:

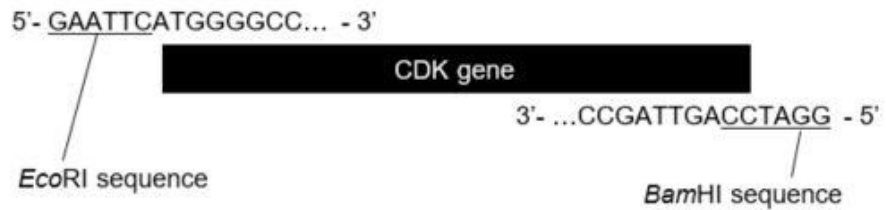


Fig. 1.1

- (i) Name **two** restriction sites that the CDK coding sequence should not contain.

..... [1]

- (ii) Suggest what additional feature the amplified gene must have to enable the expression of the eukaryotic gene.

..... [1]

- (iii) Outline three differences between prokaryotic and eukaryotic control of gene expression.

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..... [3]

- (iv) Suggest the advantage of designing primers that incorporate the restriction site.

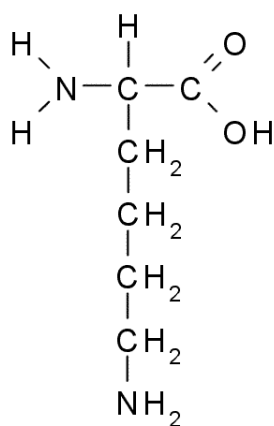
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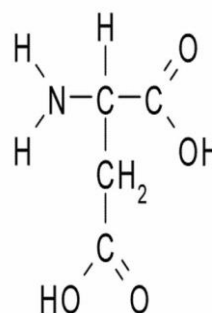
.....

..... [2]

- (b) Two of the amino acids that may be found in CDKs are shown in Fig. 1.2.



Lysine



aspartate

Fig. 1.2

With reference to the amino acids in Fig. 1.2, explain the effect of extreme pH on enzyme activity of CDKs.

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..... [3]

(c) Enzymes can be found in cell cytoplasm as well as embedded on membranes of the cell.

(i) Suggest one **important** structural difference between intrinsic membrane-bound enzymes and cytoplasmic enzymes.

.....

 [2]

(ii) Explain the significance of the difference that you have stated in (i) to the intrinsic membrane-bound enzymes.

.....

 [2]

(d) Fig. 1.3 shows the various stages of the cell cycle and how it is being regulated at the various check points.

Important control points of the cell cycle lie at the end of the G2 phase (G2/M transition), in mitosis (metaphase/anaphase transition) and in G1 phase (restriction point). Controls are shown in both solid and broken arrows.

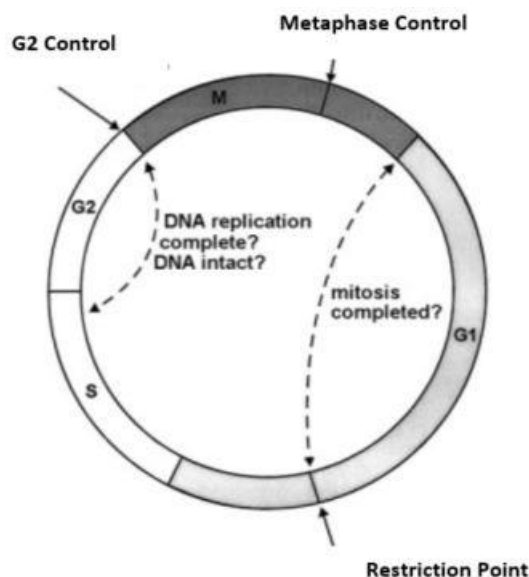


Fig. 1.3

Describe the function of metaphase control and how this may prevent the development of cancer.

[3]

- (e) Spindle fibres are polymers made from tubulin monomers. The removal of tubulin monomers causes spindle fibres to shorten. Scientists investigated the effect of the rate of tubulin removal on the speed of movement of chromatids during mitosis. The results are shown in Fig. 1.4.

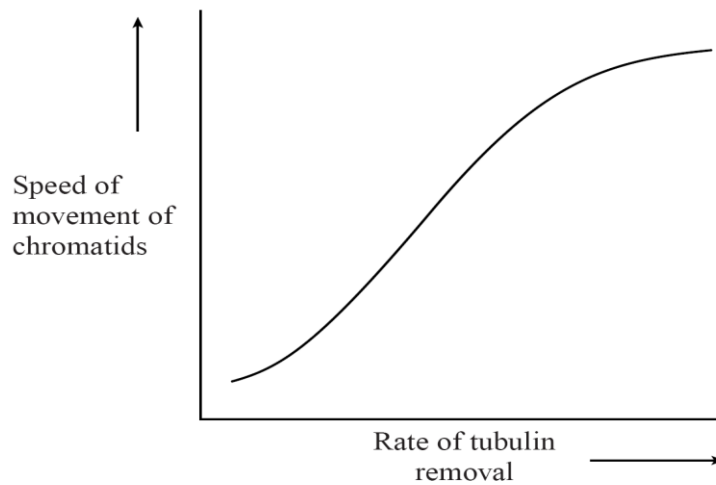


Fig. 1.4

- (i) Describe how these results support the role of spindle fibres in mitosis.

[2]

- (ii) Explain why drugs that stabilise microtubule structures are effective as anti-cancer therapeutic.

[2]

- (f) Leukemia is an uncontrolled proliferation of one type of white blood cell. One of the most common form is chronic myelogenous leukemia (CML). In most cases of CML, the leukemic cells share a chromosomal abnormality not found in any leukemic white blood cells, nor in any other cells of the patient's body.

This abnormality is shown in Fig. 1.5 where one chromosome 9 is longer than normal and one chromosome 22 is shorter than normal.

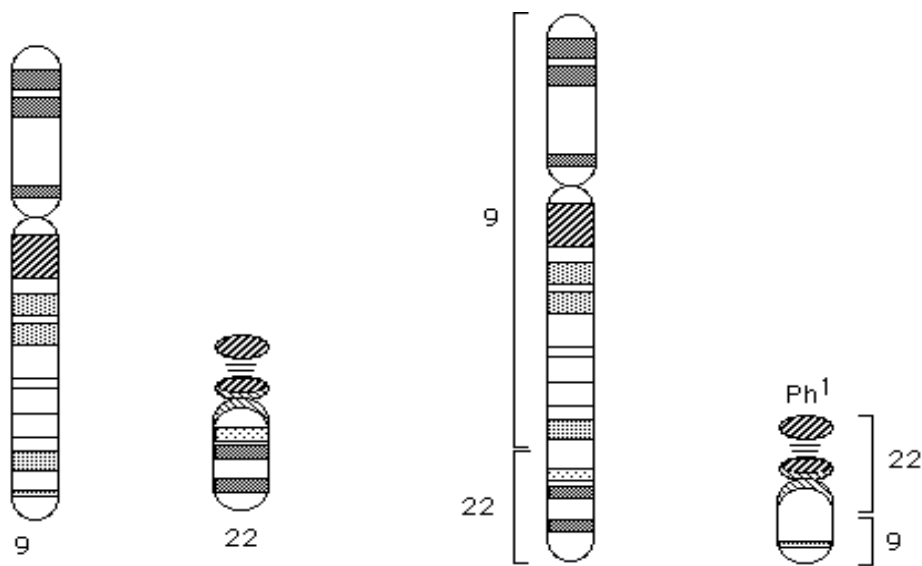


Fig. 1.5 (a) above showing the banding pattern on Normal Human chromosomes 9 and 22.

Fig. 1.5 (b) above showing the longer chromosome 9, and a shorter chromosome 22 which is known as the Philadelphia chromosome (Ph¹).

The gene that is affected in CML is the *bcr* gene on chromosome 22.

In a normal cell, *bcr* gene codes for the receptor tyrosine kinase, which receives growth factor required for cell division.

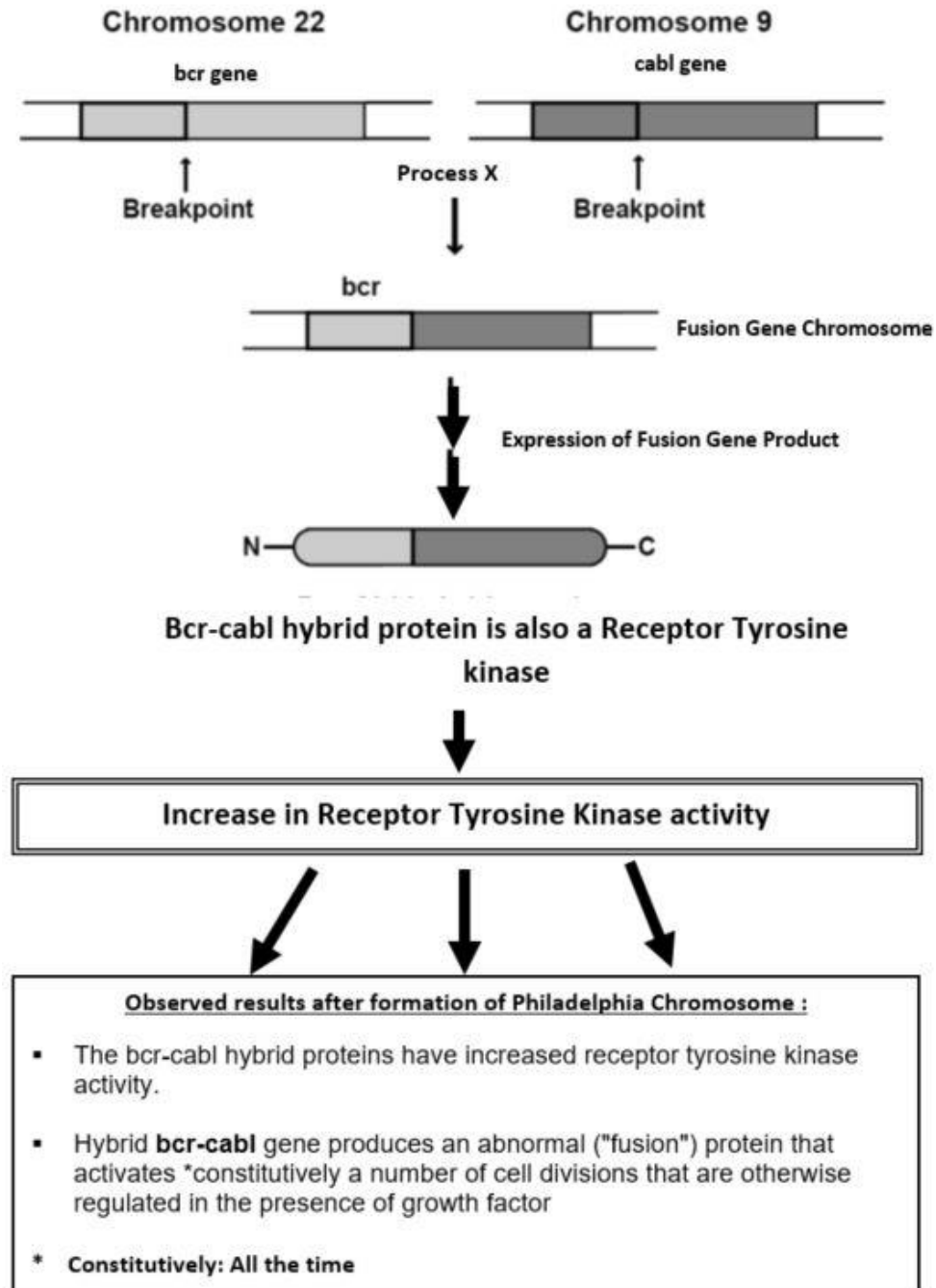


Fig. 1.6

- (i) Briefly describe the kind of mutation that occurs between chromosome 9 and 22 shown as process X in Fig. 1.6 that leads to the formation of Philadelphia chromosome (Ph¹).

.....
..... [1]

- (ii) Based on the high tyrosine kinase activity of the Bcr-cabl hybrid protein, explain whether *bcr* gene is considered a proto-oncogene or tumor suppressor gene.

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..... [2]

- (iii) Describe three mechanisms by which oncogenes can arise.

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..... [3]

- (iv)** Mutation of *p53* gene was also commonly observed in these CML cells. This additional mutation causes the rate of mitosis in these cells to increase sharply.

Explain whether this is a dominant or recessive mutation.

[3]

[Total: 30]

- 2 The spruce bark beetle feeds on and breeds in spruce trees. If a large number of beetles are on a spruce tree, the tree will die. These dead trees will appear red when viewed from the air.

Alaska has experienced recent changes in the number of spruce bark beetles. It is thought that the number of beetles is affected by climate change.

Each year, the extent of damage to the woodland was estimated by measuring the size of the 'red area' from aerial photographs.

The drought index of the woodland was also determined. A high drought index indicates warm, dry conditions and low drought index indicates cool, moist conditions.

The graphs below show the changes in 'red area', mean summer temperature and drought index in Alaskan woodland, from 1930 to 2000.

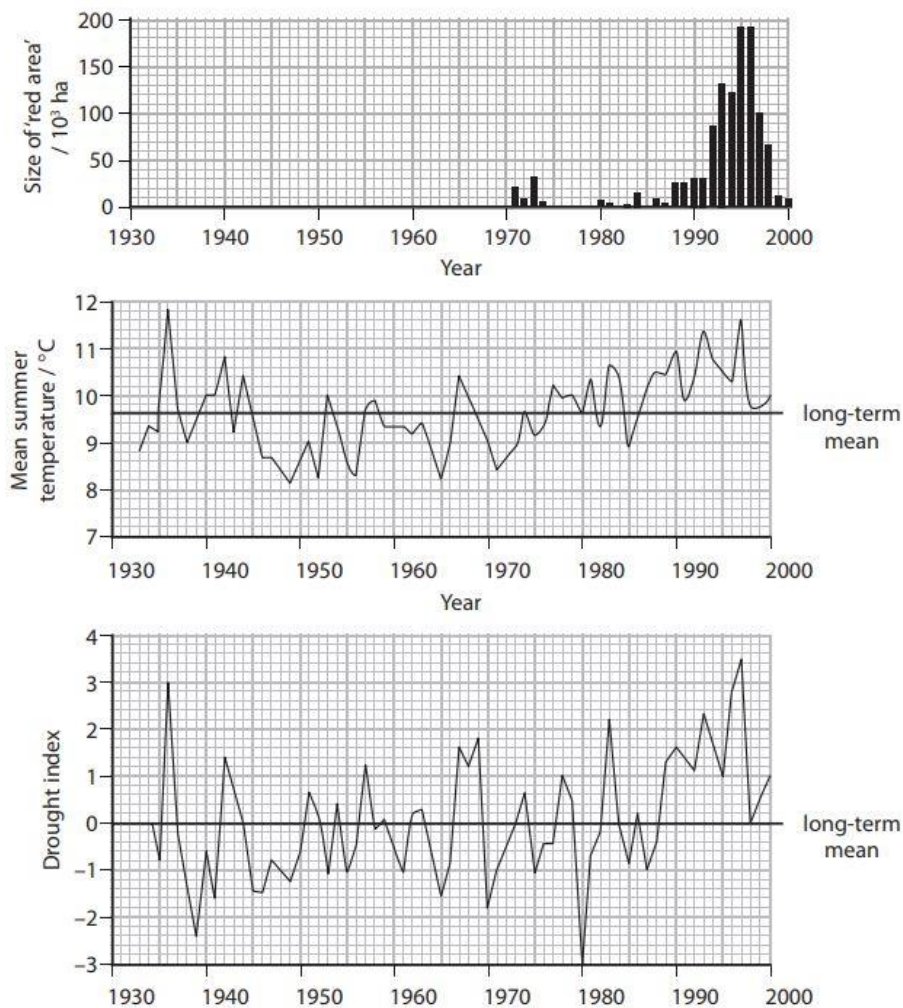


Fig. 2.1

- (a) Describe the changes in the size of the 'red area' from 1970 to 2000.

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..... [2]

- (b) Suggest why there is no data for the size of the 'red area' before 1970.

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..... [1]

- (c) Suggest why the number of spruce bark beetles is affected by temperature.

.....

.....

.....

..... [2]

- (d) Using the information in the graphs, describe the evidence for climate change being responsible for the size of the 'red area'.

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..... [3]

[Total: 8]

- 3 (a) The following boxes show the names of different stages that occur during meiosis.

Anaphase I	Metaphase II	Anaphase II
Telophase II	Prophase I	Metaphase I

State the stage(s) in which the following events occur:

Independent assortment

.....

Formation of the spindle apparatus

.....

Separation of sister chromatids

.....

Formation of nuclear membranes

.....

Chromosomes pulled to opposite poles

.....

[5]

- (b) Meiosis is used in many organisms for the production of gametes.

Explain the importance of meiosis in the production of gametes.

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[4]

- (c) Several days after fertilisation between gametes, the ball of cells becomes a blastocyst. The diagram below shows a section through a blastocyst.

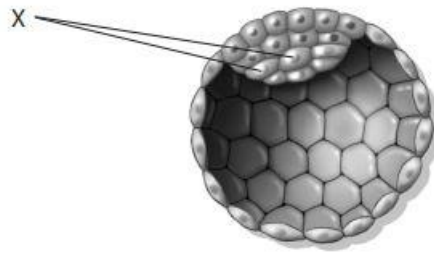


Fig. 3.1

- (i) Identify the type and state of potency of the cells labelled **X**.

.....
..... [1]

- (ii) Explain what is meant by the state of potency identified in **(c)(i)**.

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

[Total: 12]

Section B

Answer **one** question in this section.

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

Your answers must be in continuous prose, where appropriate.

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

- 4 **(a)** Explain the role of isolating mechanisms in evolution of new species. [15]
 (b) Explain, using **named** examples, how mutation can affect phenotype. [10]

[Total: 25]

- 5 **(a)** Describe how non-cyclic photophosphorylation produces ATP and [15]
 reduced NADP, and outline the steps of the Calvin cycle.
 (b) Outline the role of anaerobic respiration in both mammals and yeast [10]
 cells.

[Total: 25]