

NANYANG JUNIOR COLLEGE  
JC 2 PRELIMINARY EXAMINATIONS  
Higher 1

CANDIDATE  
NAME

CLASS

## BIOLOGY

Paper 2 Core Paper

**8875/02**

**September 2015**

**2 hours**

Additional Materials: Answer Paper

### READ THESE INSTRUCTIONS FIRST

Write your name and CT on all the work you hand in.  
Write in dark blue or black pen on both sides of the paper.  
You may use soft pencil for any diagrams, graphs or rough working.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

#### Section A

Answer **all** questions,

#### Section B

Answer any **one** question.

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

For Examiner's Use	
Section A	
1	
2	
3	
4	
Section B	
Total	

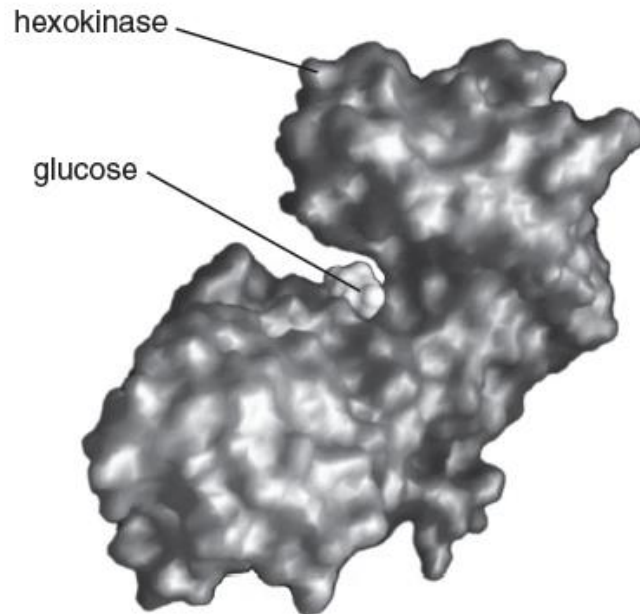
This document consists of **14** printed pages and **0** blank pages.

**[Turn over**

## Section A

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

- 1 **Fig. 1.1** is a computer-generated image of the enzyme hexokinase binding with its substrate, glucose. The product of the enzyme-catalysed reaction is glucose-6-phosphate.



**Fig. 1.1**

- (a) Hexokinase binds with glucose using the induced fit mechanism.  
Describe how an enzyme-substrate complex forms by this mechanism.

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[3]

- (b) Suggest how enzymes which use the induced fit mechanism can be less affected by competitive inhibitors than those which use the lock and key mechanism.

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[2]

- (c) Glucose can enter cells by active transport or facilitated diffusion.  
Glucose-6-phosphate is a molecule that cannot move out of cells.

(i) Describe two **differences** between active transport and facilitated diffusion.

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[2]

(ii) Suggest why glucose-6-phosphate cannot move out of cells.

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[2]

**[Total: 9]**

- 2 (a) Explain what is meant by the term heterozygous genotype.

*heterozygous:*

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*genotype:*

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[2]

- (b) Tail length in cats is determined by the Japanese Bobtail gene. The normal wild-type allele T is dominant and codes for normal tail length in cats. The mutant allele t is recessive and codes for a short tail, as found in the Japanese Bobtail breed, hence the name.

Coat colour in cats is determined by the *tyr* gene, which codes for tyrosinase enzyme. This enzyme is involved in pigment production, and controls the intensity of body colour in cats.

There are five different alleles for the *tyr* gene, namely full colour **B**, Burmese **b<sup>M</sup>**, Siamese **b<sup>s</sup>**, blue-eyed albino **b<sup>A</sup>**, and albino **b**. Each allele gives rise to a different mutant tyrosinase enzyme, resulting in the different phenotypes observed.

**Table 2.1** below shows the different breeds possible.

**Table 2.1**

	<b>B</b>	<b>b<sup>M</sup></b>	<b>b<sup>s</sup></b>	<b>b<sup>A</sup></b>	<b>b</b>
<b>B</b>	Normal	Normal	Normal	Normal	Normal
<b>b<sup>M</sup></b>		Burmese	Tonkinese	Burmese	Burmese
<b>b<sup>s</sup></b>			Siamese	Siamese	Siamese
<b>b<sup>A</sup></b>				Blue-Eyed Albino	Blue-Eyed Albino
<b>b</b>					Albino

- (i) With reference to **Table 2.1** above, determine the relative dominance of the alleles **B**, **b<sup>M</sup>**, and **b<sup>s</sup>**.

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[2]

- (ii) A homozygous Burmese female cat with normal tail was crossed with a homozygous Siamese male cat with a short tail. The  $F_1$  offspring were then sibling-mated to form the  $F_2$  generation. Draw a genetic diagram to show the expected genotypes and phenotypes of the  $F_2$  offspring.

- (c) Siamese cats have a unique coat pattern. They have a white body and black extremities. The extremities, which include ears, face, legs and tail, are cooler regions. These cats possess the *tyr* allele  $b^s$ , which codes for a temperature-sensitive mutant tyrosinase enzyme. **Fig. 2.2** below shows a diagram of a typical Siamese cat.



**Fig. 2.2**

Suggest how the environment results in the characteristic coat pattern in Siamese cats.

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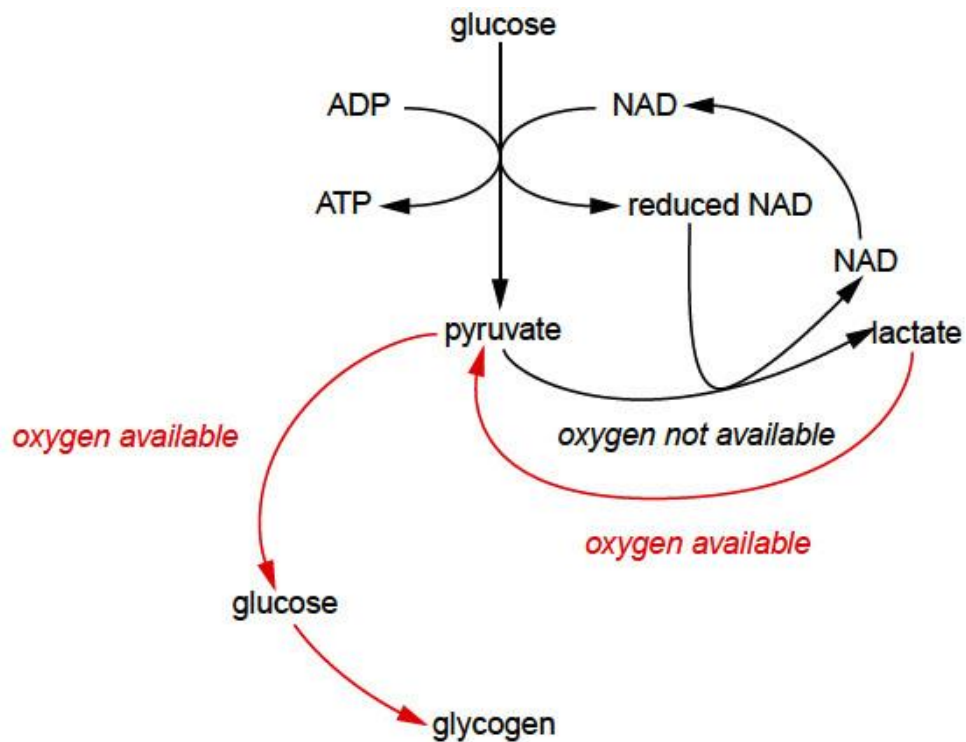
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[2]

**[Total: 10]**

3 **Fig. 3.1** outlines some steps in glucose metabolism in mammalian cells.



**Fig. 3.1**

(a) With reference to **Fig. 3.1**,

(i) explain why, in the absence of oxygen, pyruvate needs to be converted to lactate;

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[2]

(ii) name the type of reaction **and** the type of bonds formed when glucose molecules are used to make glycogen.

**Type of reaction:**

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**Type of bonds:**

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[1]

- (b) ATP is often known as the universal 'energy currency'.  
Outline how ATP is suitable for acting as an energy currency.

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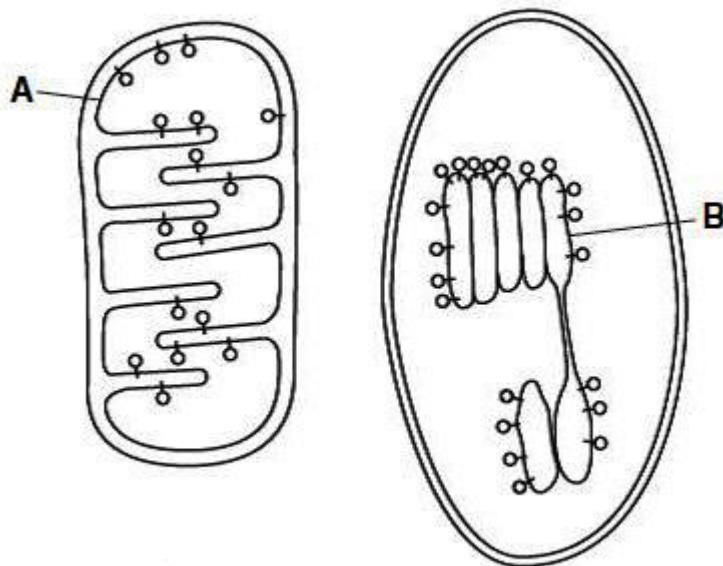
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[2]

- (c) Most ATP is made in cells by membrane systems that create proton gradients by pumping protons from one compartment to another.

**Fig. 3.2** shows two such membrane systems.



**Fig. 3.2**

- (i) Draw arrows onto each of the membrane systems in **Fig. 3.2** to show the direction in which protons are pumped.

[1]



- (ii) Outline how energy is made available for pumping protons across such membranes.

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[3]

- (iii) Explain how ATP synthase is involved in the production of ATP.

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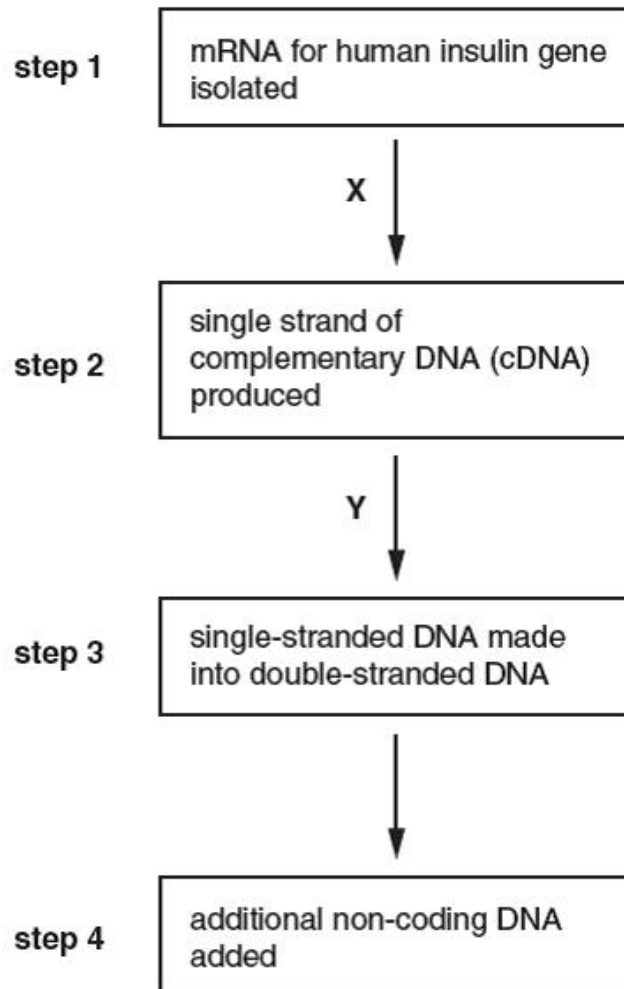
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[2]

**[Total: 11]**

- 4 **Fig. 4.1** outlines how a gene coding for human insulin is produced by genetic engineering techniques.



**Fig. 4.1**

- (a) (i) Name the enzymes **X** and **Y**.

**X**

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**Y**

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[2]

- (ii) Explain why the starting point in this procedure is mRNA.

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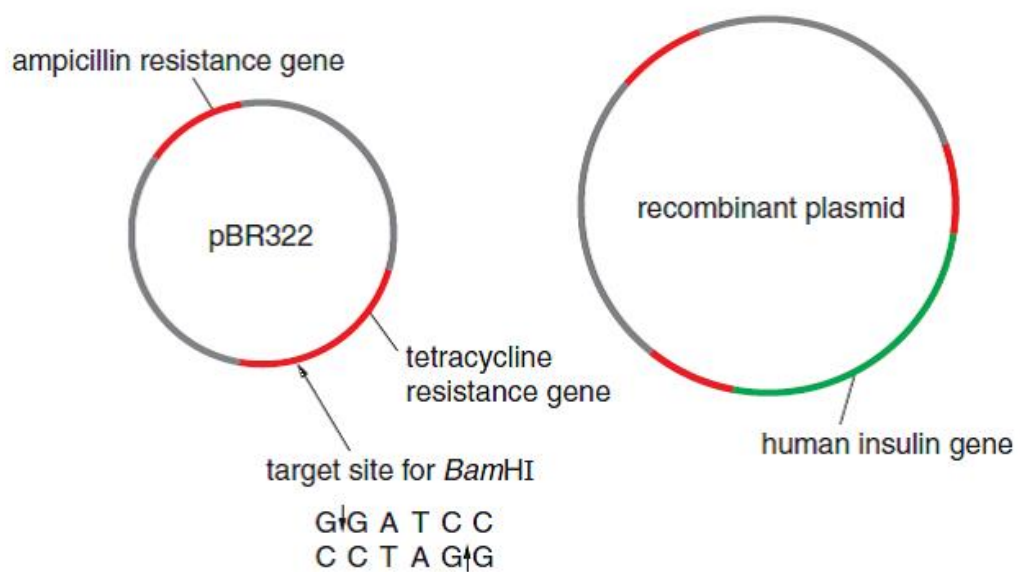
[2]

- (b) The artificial plasmid, pBR322, was constructed to act as a vector. It has often been used to insert human genes, such as the human insulin gene, into the bacterium, *Escherichia coli*.

The plasmid was constructed to include two genes, each giving resistance to a different antibiotic: an ampicillin resistance gene and a tetracycline resistance gene. The plasmid also has a target site for the restriction enzyme, *Bam*HI, in the middle of the tetracycline resistance gene.

A pBR322 plasmid was cut using *Bam*HI and the cDNA gene for human insulin inserted into it.

**Fig. 4.2** shows pBR322 and the recombinant plasmid.

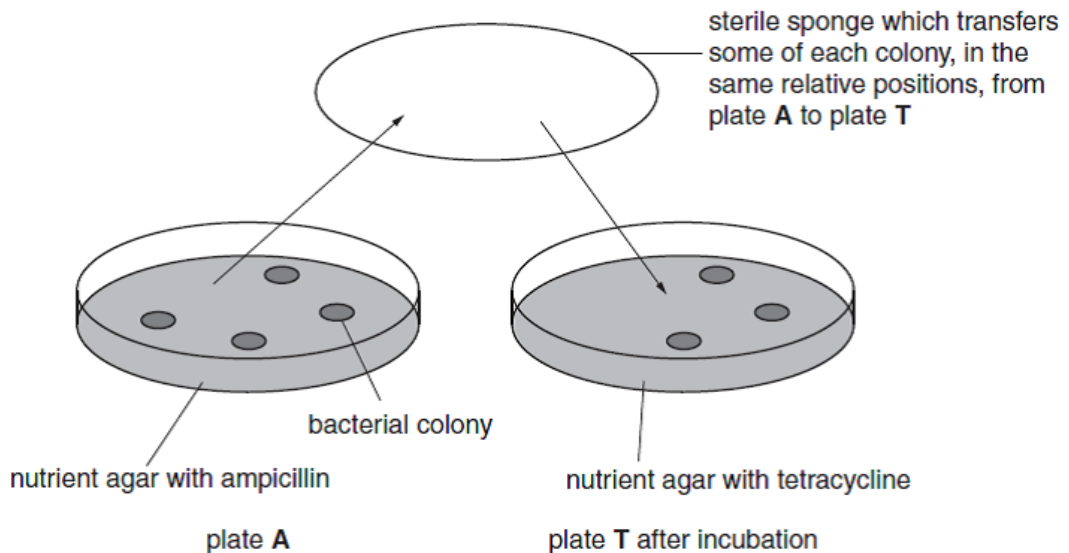


**Fig. 4.2**

- (c) Bacteria were then mixed with the recombinant plasmids shown in **Fig. 4.2**. Those bacteria which had successfully taken up recombinant plasmids were identified using the following steps:

**step 1** – the bacteria were spread onto culture plates containing nutrient agar and ampicillin and incubated to allow colonies to form

**step 2** – some bacteria from each of the colonies growing on these plates were transferred to plates containing nutrient agar and tetracycline, as shown in **Fig. 4.3**.



**Fig. 4.3**

- (i) Explain why the bacteria were first spread onto plates containing ampicillin.

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[2]

- (ii) Explain why it is important, for identifying bacteria that have successfully taken up the recombinant plasmid, that on pBR322 the target site for *Bam*HI is in the middle of the tetracycline resistance gene.

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[3]

- (iii) Use a label line and the letter **C** to identify, on **Fig. 4.3**, a colony of bacteria that contain the recombinant plasmid.

[1]

**[Total: 10]**

**Section B**

Answer **one** question.

Write your answers on the separate answer paper provided.

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.

- 5**   **(a)** Outline the arrangements and functions of named membranes within the cell. [7]
- (b)** Explain how the fluid mosaic model of cell surface membrane facilitates the transport of substances. [7]
- (c)** The enzyme catalase is found in potatoes. This enzyme catalyses the breakdown of hydrogen peroxide to water and oxygen.  
          Describe an investigation into the effect of substrate concentration on the activity of catalase in potatoes, by measuring the release of oxygen. [6]

**[Total: 20]**

- 6**   **(a)** Compare the process of DNA replication with polymerase chain reaction (PCR). [7]
- (b)** Explain how sexual reproduction can lead to variation. [8]
- (c)** Following cytokinesis, one of the daughter cells may not have a nucleolus.  
          This cell is able to divide once more and then the new daughter cells die.

Explain how the cell is able to survive for one more cell division and suggest why the new daughter cells then die. [5]

**[Total: 20]**