



**CATHOLIC JUNIOR COLLEGE**  
**JC2 PRELIMINARY EXAMINATIONS**  
**Higher 1**

**CANDIDATE  
NAME**

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**CLASS**

2T
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**INDEX  
NUMBER**

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## **BIOLOGY**

**8875/02**  
**23<sup>rd</sup> August 2016**  
**2 hours**

Additional Materials: Writing Paper

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### **READ THESE INSTRUCTIONS FIRST**

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

Write in dark blue or black pen on both sides of the paper. **[PILOT FRIXION ERASABLE PENS ARE NOT ALLOWED]**

You may use a soft pencil for any diagrams, graphs or rough working.

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

There are two sections in this paper.

#### **Section A]**

Answer all questions

#### **Section B]**

Answer one questions. Answer each part on a **separate** piece of paper.

At the end of the examination, fasten all work securely together.

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

For Examiner's Use	
Section A	<div></div> 40
1 [8]	
2 [11]	
3 [10]	
4 [11]	
Section B	<div></div> 20
5 or 6	
TOTAL	<div></div> 60

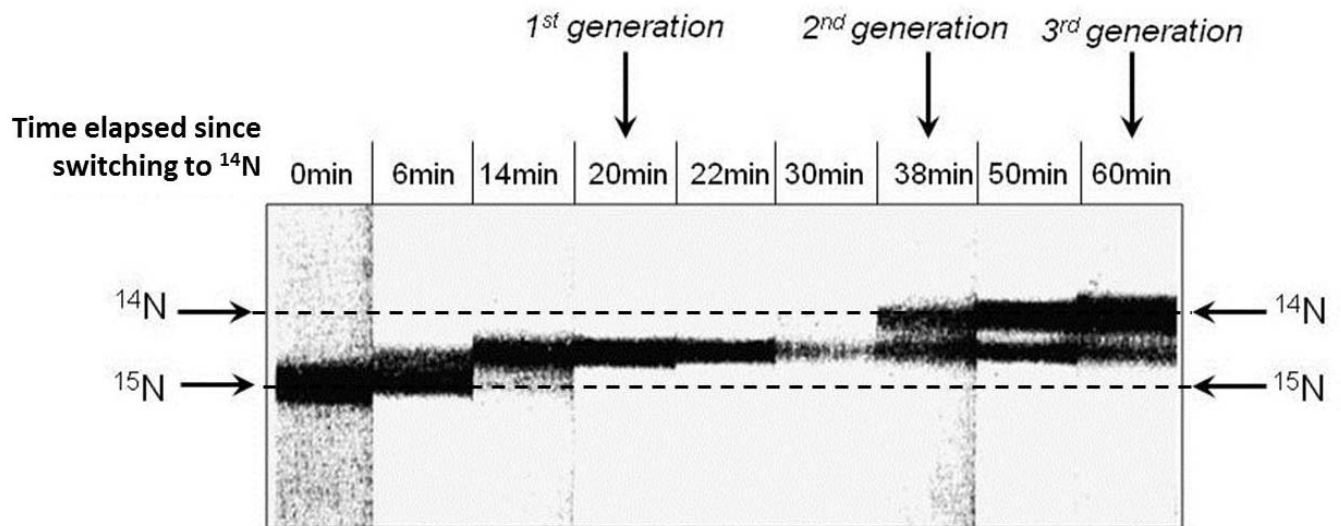
## Section A

Answer **all** questions in this section.

- 1** Cells were transferred and grown in  $^{15}\text{N}$  medium for many generations before they were transferred to  $^{14}\text{N}$  medium again and allowed to divide.

DNA was extracted periodically from the culture and subjected to density gradient centrifugation using caesium chloride.

Fig. 1.1 shows the density gradient results across three generations.



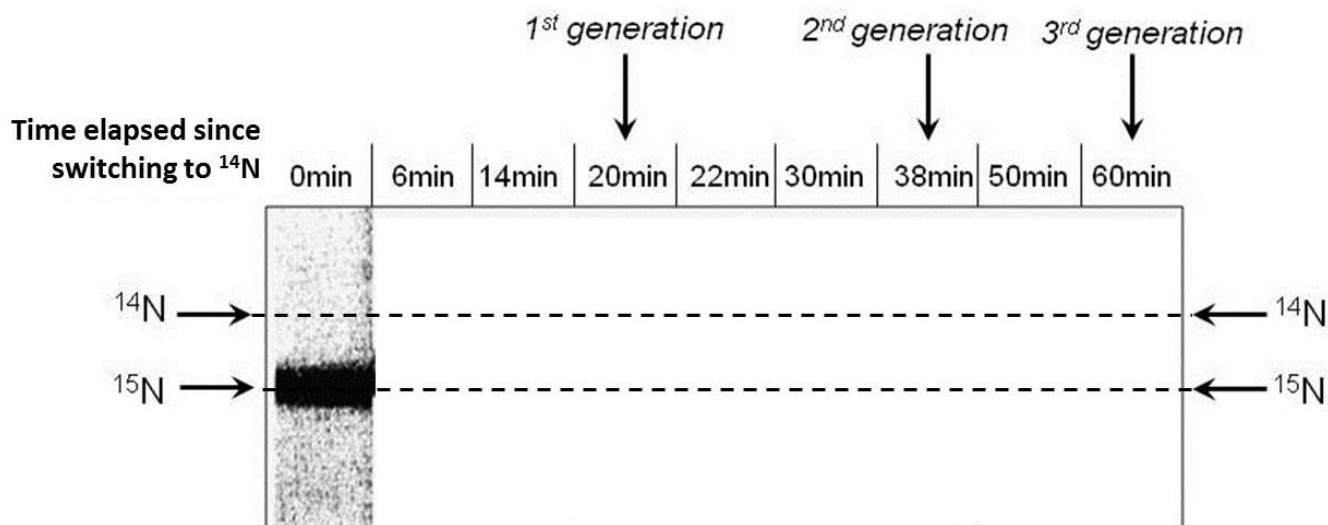
**Fig. 1.1**

- (a)** With reference to Fig. 1.1, account for the model of DNA replication which these cells undergo.

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

- (b) State another model of DNA replication not shown in Fig. 1.1 draw only its band patterns for the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> generations in the Figure below. [2]

Model of DNA replication: .....



DNA replication has many similarities with translation even though the products formed are different. Some of the similarities are that they both take place in 3 different stages (initiation, elongation, termination), both require energy, monomers for extension, a template for product synthesis as well as bond formation involving the removal of a water molecule.

- (c) State three other similarities between the cellular process shown in Fig. 1.1 and translation.

.....

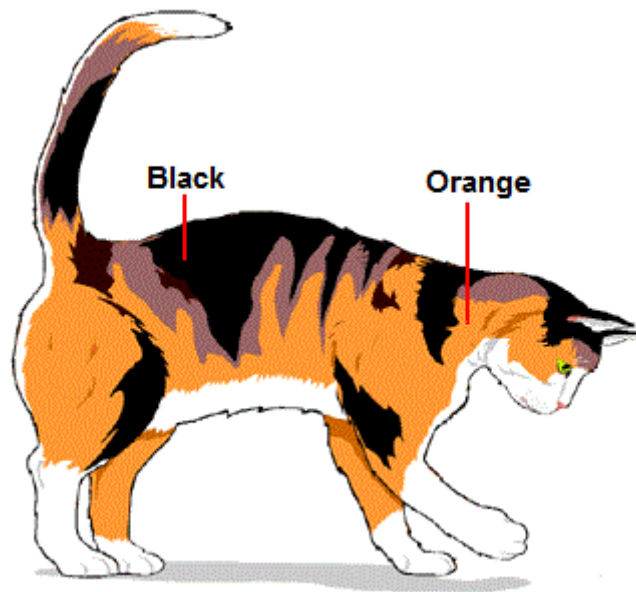
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.....[3]

[Total: 8]

- 2** Fig. 2.1 shows a Calico cat with a mosaic coat with patches of orange and black. It is known that fur coat colour in cats is determined by a single gene. Only female cats can develop calico fur coat. Male cats usually have only orange or black fur coat.



**Fig. 2.1**

- (a) Identify the type(s) of inheritance determining calico fur coat colour in cats.

.....[1]

- (b) Using B to represent allele for black coat and R to represent allele for orange coat, draw a genetic diagram to show how a cat-breeder can obtain calico cat from a cross between a pure-breeding black male and an orange female cat. [5]

Tay–Sachs disease is an autosomal recessive disease which causes a progressive deterioration of nerve cells, mental and physical abilities in patients. This disease is caused by a mutation in the hexA gene found on chromosome 15, which codes for the alpha-subunit of hexosaminidase A, a lysosomal enzyme.

A man who is heterozygous at the locus for the blood type B antigen has a son with a woman with blood type O. Both parents are carriers for Tay-Sachs disease. Blood types are determined by genes on chromosome 9.

**(c)** Draw a genetic diagram to determine the possible phenotypes of their child.

[5]

**[Total: 11]**

- 3 The Grand Canyon National Park is home to two groups of squirrels. The Albert squirrels *Sciurus aberti* live generally on the south rim of the canyon and the Kaibab squirrels *Sciurus kaibabensis* live on the north rim of the canyon (Fig. 8.1 and Fig. 8.2).

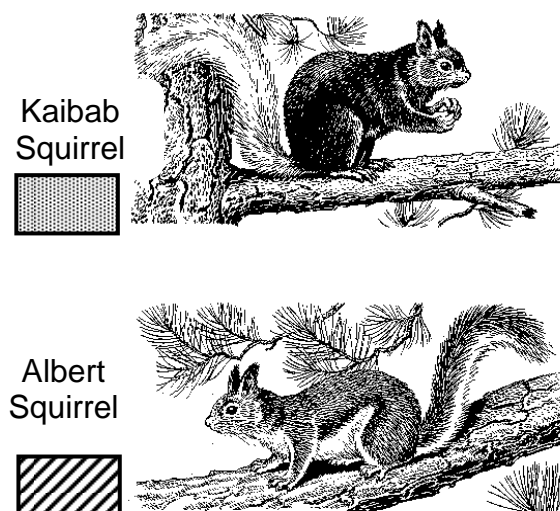


Fig. 8.1

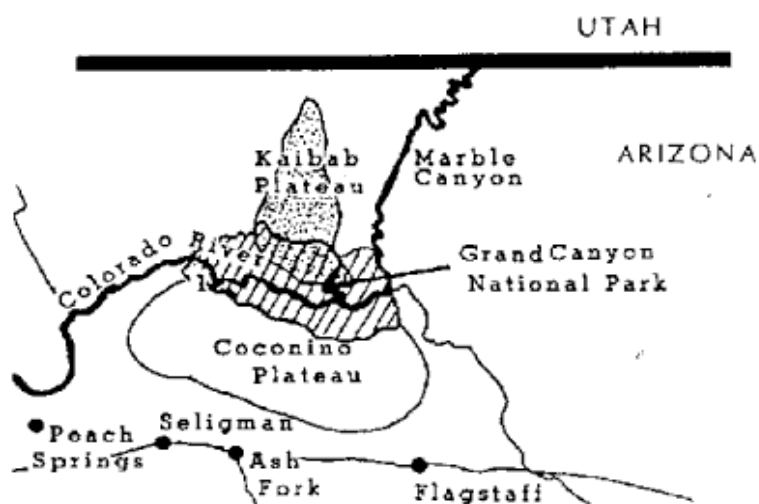


Fig. 8.2

The north rim is about 370 m higher than the south rim. Almost twice as much precipitation falls on the north rim than on the south rim every year. The two groups share many characteristics, but they do not look the same, both groups have tasselled ears, but each group has a unique fur colour pattern.

- (a) Explain which Darwinian principles can be applied from the above information on *S. aberti* and *S. kaibabensis*.

.....

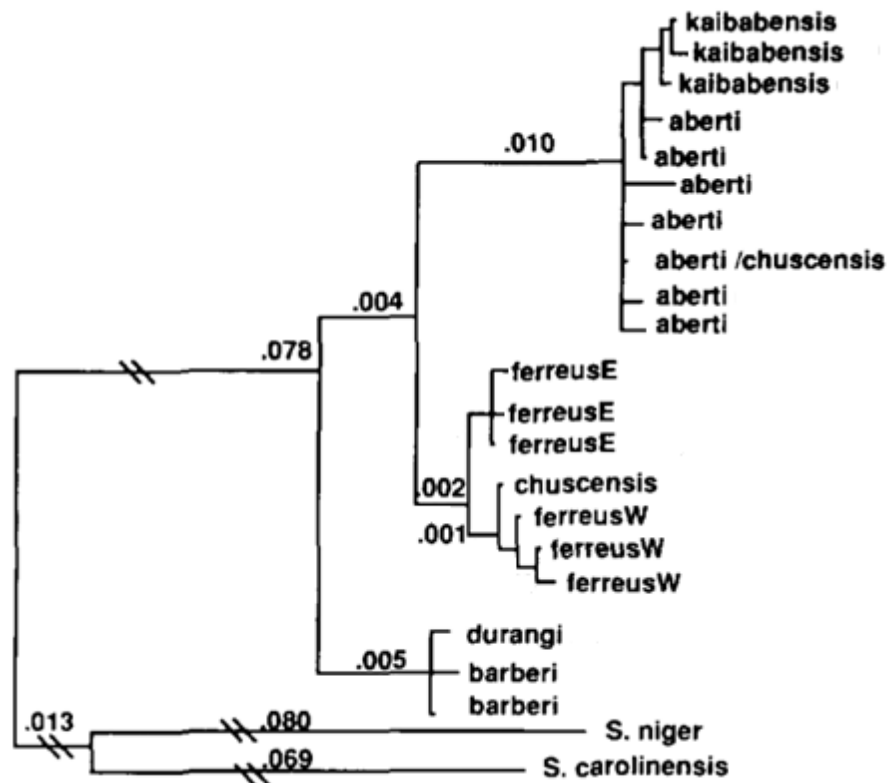
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.....[4]

Several studies have been done on the phylogenetic relationship of the squirrels in and around the Grand Canyon region. Fig. 8.3 is one such study based on cytochrome b DNA sequences.



**Fig.8.3** Phylogenetic relationship between six *sciurus* subspecies base on cytochrome b sequences constructed by the neighbour-joining method of Saitou and Nei (1987) using the *S. niger* and *S. carolinesis* (Thomas and Martin 1993) sequences as outgroups. Branch lengths and confidence probabilities are noted above and below the branches respectively.

- (b)** With reference to information already given and also to Fig. 8.3, it is clear that divergent evolution or adaptive radiation is occurring in the evolution of *S. alberti* and *S. kaibabensis*

Explain why it is not convergent evolution.

.....[2]



- (c) With reference to information in Fig. 8.2 and Fig. 8.3, explain how natural selection contributes toward evolution of the two species of squirrel.

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.....

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.....

.....[4]

**[Total: 10]**

- 4 Human Growth Hormone is important to augment normal growth and development in the treatment of individuals with dwarfism. Fig. 4.1 shows how human growth hormone can be produced via expression of recombinant DNA in *Escherichia coli* host cells.

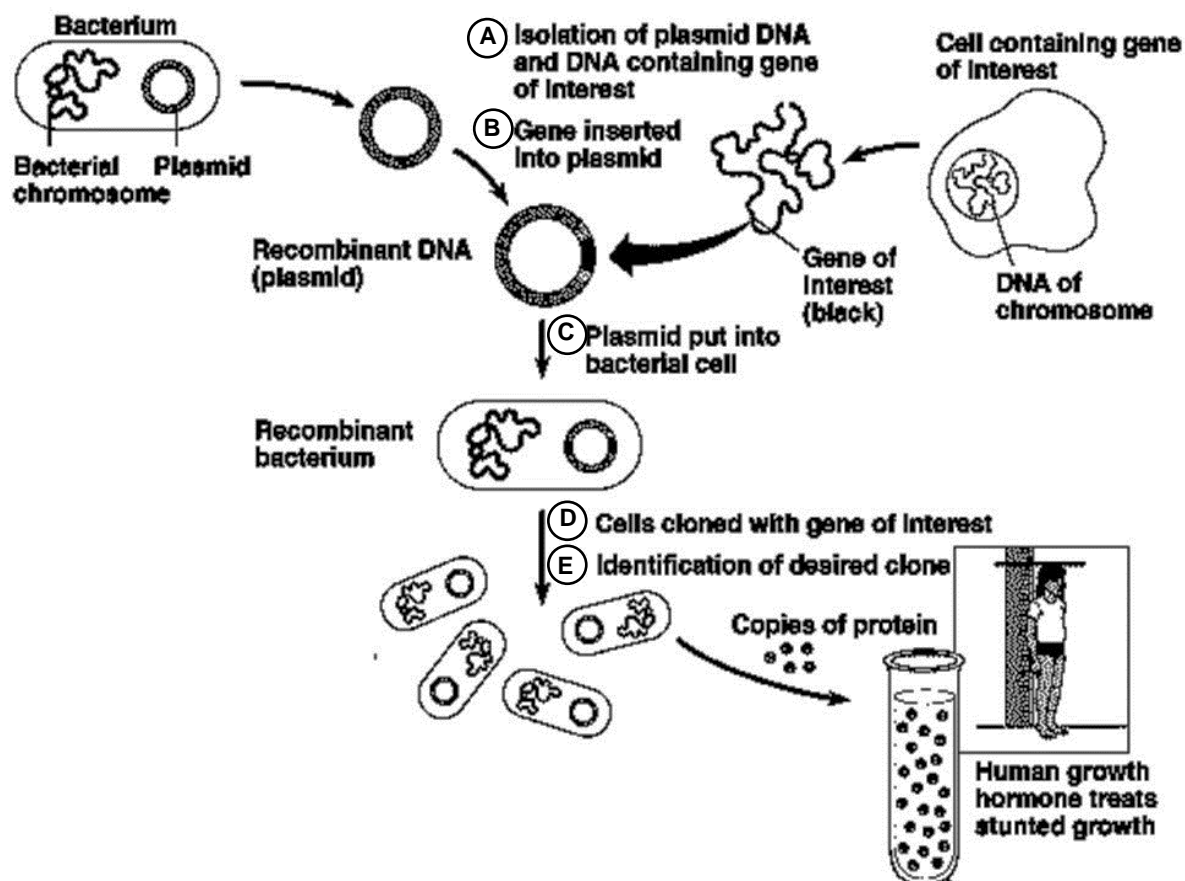


Fig. 4.1

- (a) Explain what is meant by recombinant DNA.

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

- (b) Name the process required in the following procedure in Fig 4.1.

C : .....

E : .....

[1]

**(c)** The gene of interest cannot be taken directly from DNA of chromosome but require additional processing in order to produce functional protein.

**(i)** With reference to Fig. 4.1, explain why the gene of interest cannot be taken directly from chromosomal DNA.

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

**(ii)** Outline the additional processing required to yield the gene of interest prior to insertion into the plasmid.

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

**(d)** State one possible pair of gene markers present on the cloning site of the plasmid for the identification of desired clone in Fig. 4.1.

.....[1]

**(e)** Outline the process for Stage E in Fig 4.1 using one of the gene markers in (d).

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

**[Total: 11]**

## Section B

Answer **One** questions. Answer each part on a **separate** piece of paper.

Write your answers on separate answer paper provided.

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

Your answer must be in continuous prose, where appropriate.

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

- 5**    **(a)**    Describe the process of mitosis and its importance. [6]
- (b)**    Outline the process of chemiosmosis during photosynthesis and respiration. [4]
- (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 temperature on the activity of catalase in potatoes, by measuring the release of oxygen. [10]
- 6**    **(a)**    Using appropriate examples, explain how the unique features of stem cells contribute to their functions in a living organism. [10]
- (b)**    Discuss the pros and cons of genetically-modified crop plants. [10]

**END OF PAPER**