

Name	Subject Class	Class	Candidate Number
	2BIX01		



ANGLO-CHINESE JUNIOR COLLEGE
Preliminary Examination 2015

BIOLOGY

HIGHER 1

Paper 2

8875/02
24 AUGUST 2015
2 hours

Additional Material: Writing Paper

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on this answer booklet.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.

Section A

Answer **all** questions.

Section B

Answer any **one** question.

At the end of the examination, circle the number of the Section B question you have answered in the grid opposite.
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	
5 or 6	
Total	60

- 1 (a) Fig. 1.1 is a schematic diagram showing the transport pathways of extracellular and intracellular materials for digestion in a mammalian cell. Depending on the types of digested material, three possible pathways are initiated to deliver these materials for digestion within lysosomes, of which two are labelled as **A** and **B**.

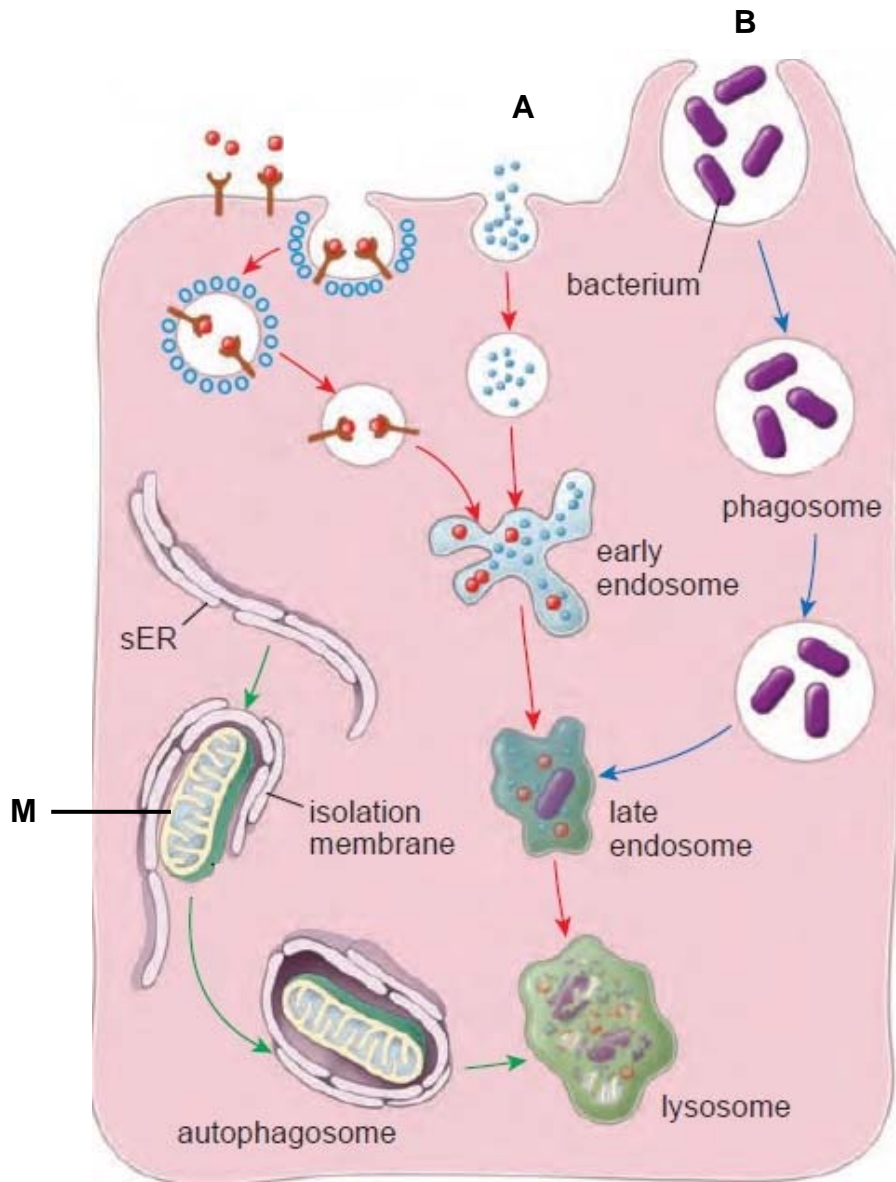


Fig. 1.1

- (i) State **one** property of the plasma membrane and explain how it enables process **A** to be carried out by a cell. [2]

- (ii) Organelle **M** is a mitochondrion with its inner membrane thrown into numerous folds. Explain the advantage of this feature to a cell undergoing aerobic respiration. [2]

- (iii) Degradation of worn out organelles such as mitochondria occurs inside most cells via autophagy. With reference to Fig. 1.1, describe the process of autophagy. [2]

- (b) Lysosomes are rich in enzymes such as proteases and nucleases. The lysosomal membrane contains an unusually large amount of integral proteins, which are highly glycosylated with oligosaccharides on the surface of membrane facing the interior.

- (i) Briefly describe how an oligosaccharide is formed from glucose. [3]

- (ii) Suggest the role of these glycosylated proteins in lysosomes. [1]

[Total: 10m]

- 2 (a) Cystic fibrosis (CF) in humans is caused by mutations of a gene coding for the transmembrane protein called the cystic fibrosis transmembrane conductance regulator (CFTR) which acts as an ion pump. A large number of different mutations of the gene have been found. Explain what is meant by a gene mutation. [3]

CFTR regulates the transport of chloride ions (Cl^-) across the plasma (cell surface) membrane. The transport of Cl^- by epithelial cells expressing the normal *CFTR* allele was compared with that by epithelial cells expressing two different types of mutant *CFTR* alleles. The results are shown in Table 2.1 where normal digestive function of the pancreas associated with a particular allele is indicated with a tick (✓) and the absence of normal functioning is indicated with a cross (✗).

Table 2.1

<i>CFTR</i> allele	Percentage of Cl^- transported in comparison with normal allele	Normal digestive function in pancreas
Normal	100	✓
Mutation 1	6	✗
Mutation 2	41	✓

- (b) With reference to the information given in Table 2.1, explain the different effects of mutations 1 and 2 on the digestive function of the pancreas. [4]

- (c) About 80-90% of CF patients have pancreatic insufficiency, which means that the pancreas no longer functions at a level needed to digest food. Pancreatic tissues that express mutant *CFTR* alleles secrete acidic fluids into the lumen of the pancreatic duct, whereas secretions by tissues expressing the normal allele are alkaline. CF patients produce large amounts of thick, sticky mucus which can clog up the airways of the lungs, the pancreatic duct, the bile duct and the reproductive ducts.

Fig. 2.1 shows how the presence of thick, sticky mucus causes blockage in the pancreatic duct.

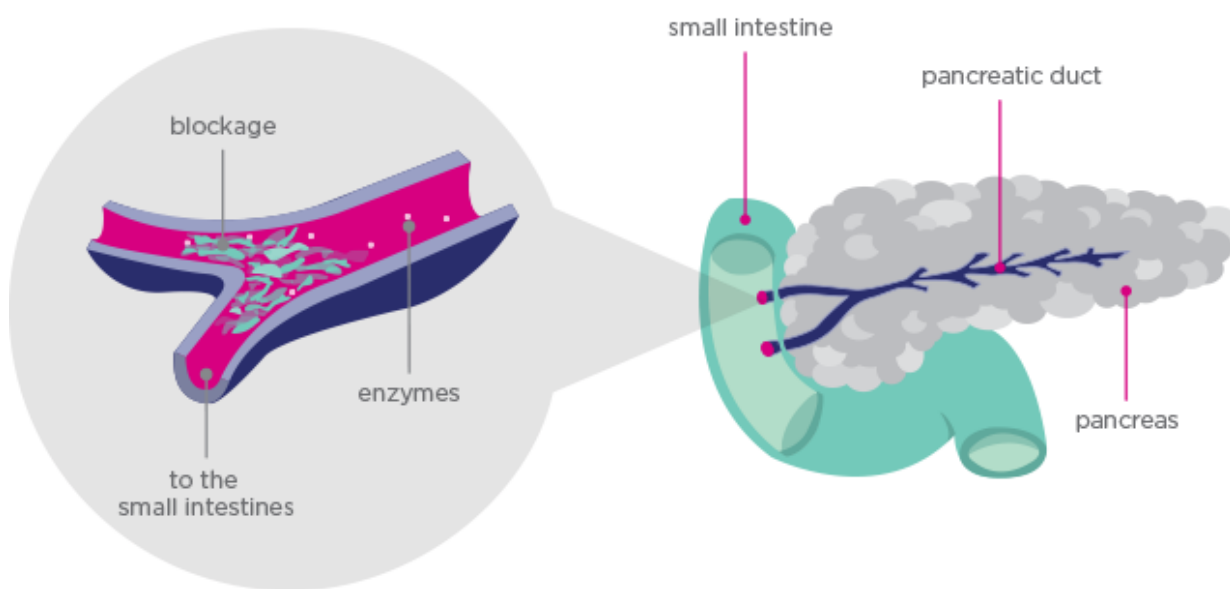


Fig. 2.1

Suggest how pancreatic tissues expressing mutant *CFTR* alleles may lead to maldigestion in CF patients. [2]

- (d) CF patients undergo enzyme replacement therapy to help them digest food properly. The enzymes are provided in the form of a tablet, powder or a capsule. Explain why the therapy is **not** an effective permanent solution to treat pancreatic insufficiency. [1]

[Total: 10m]

- 3 (a)** Fragile X Syndrome (FXS) is a sex-linked recessive genetic disease in human that causes intellectual disabilities ranging from mild to severe.

A woman who is a carrier of FXS with blood group AB married a man suffering from FXS with blood group O.

Using a genetic diagram, determine the probability of the couple having a normal boy with blood group B. [5]

- (b) The disorder FXS is caused by insertion of multiple trinucleotide (CGG) repeats in the gene. In order to make a definitive diagnosis of FXS, genetic testing is conducted to determine the presence of trinucleotide repeats. Fig. 3.1 shows both the normal and mutant alleles.

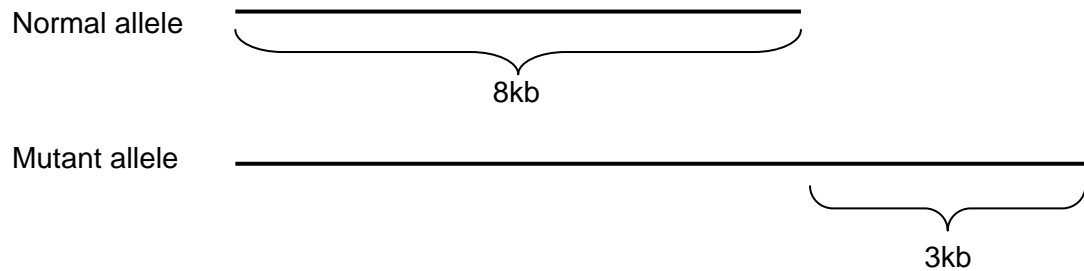
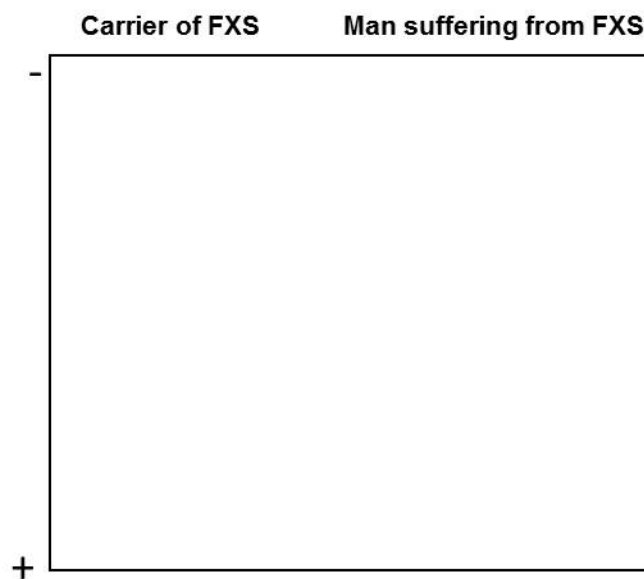


Fig. 3.1

In order to conduct a genetic test, two DNA samples were isolated from a carrier of FXS and a man suffering from FXS. The DNA samples are amplified using PCR followed by analysis using gel electrophoresis.

- (i) Describe the principles of gel electrophoresis. [2]

- (ii) In the gel electrophoregram below, draw and indicate the size of the bands you would expect to see from the two DNA samples isolated. [3]



[Total: 10m]

- 4 (a) BT corn is a genetically engineered corn that contains the gene for the toxin found in *Bacillus thuringiensis*. It has been planted extensively in various parts of the world. As the amount of BT corn plantation increases over the years, the number of species of corn borer that are resistant to BT toxin increases proportionally as well.

(i) Explain the advantage of genetically engineering the BT corn. [2]

(ii) Explain the evolution of the resistant species of corn borers to BT corn. [4]

- (b) BT toxin has been found to bind to the transmembrane protein cadherin, found in the mid-gut of the European corn borer. Cadherin genes can also be found in a wide variety of organisms, from insects to mammals. They have roles in the central nervous system as well as in cell-cell adhesion. However BT toxin can only bind to cadherin proteins on the cells in insects like the European corn borer but not to those found in mammals.

With reference to the information above and your knowledge on molecular homology, explain how the presence of different cadherin genes between different organisms can support Darwin's theory of descent with modification. [4]

[Total: 10m]

Section BAnswer **EITHER 5 OR 6.**

Write your answers in the lined pages 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.

EITHER

- 5** (a) Outline the differences between facilitated diffusion and exocytosis. [6]
(b) Describe the roles of the different RNA molecules involved in translation. [8]
(c) Discuss the social implications of genetically modified organisms. [6]

OR

- 6** (a) Compare the structure of amylopectin and haemoglobin. [6]
(b) Discuss the importance of genetic variation in natural selection and evolution. [6]
(c) Outline the large scale production of insulin using genetic engineering. [8]

[Total: 20m]

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