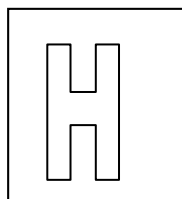


Candidate Name: _____

Class Adm No

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2017 Promotional Examination II Pre-University 2

H1 Biology

8875/02

Paper 2

12 September 2017

Additional material: writing papers

2 hours

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your Admission number and name 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** questions in the space provided in the question paper.

Section B

Answer **any one** question in the writing papers provided.

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

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

This question paper consists of 15 printed pages

[Turn over

Answer **all** questions in this section.

1. Measurement of cellular DNA content and the analysis of the cell cycle can be performed by flow cytometry. The DNA content of retinal cells of zebrafish is analysed and Fig. 1.1 show the number of cells at different stages of the cell cycle.

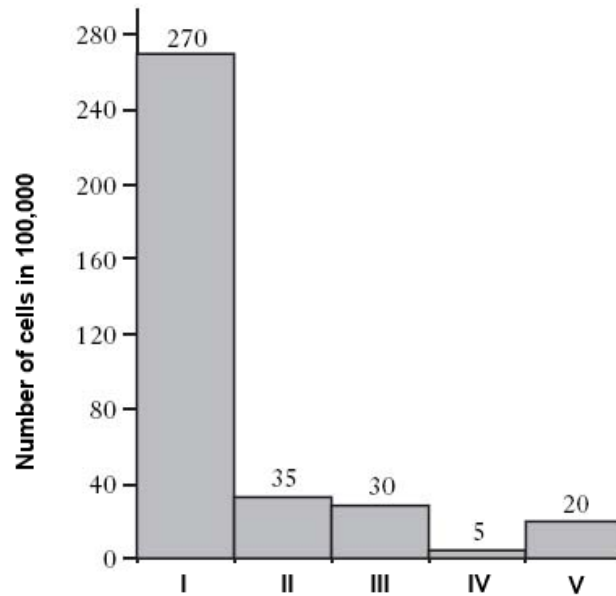


Fig. 1.1

(a)

- (i)** Identify which stage (I to V) correspond to interphase.

.....[1]

- (ii)** Suggest a reason for your answer in **(a)(i)**.

.....
[1]

- (iii)** Explain the importance of DNA replication before mitosis.

.....

[2]

Fig. 1.2 shows the electronmicrographs of three zebrafish retinal cells (**A** to **C**). Each cell is undergoing a different stage of mitosis.

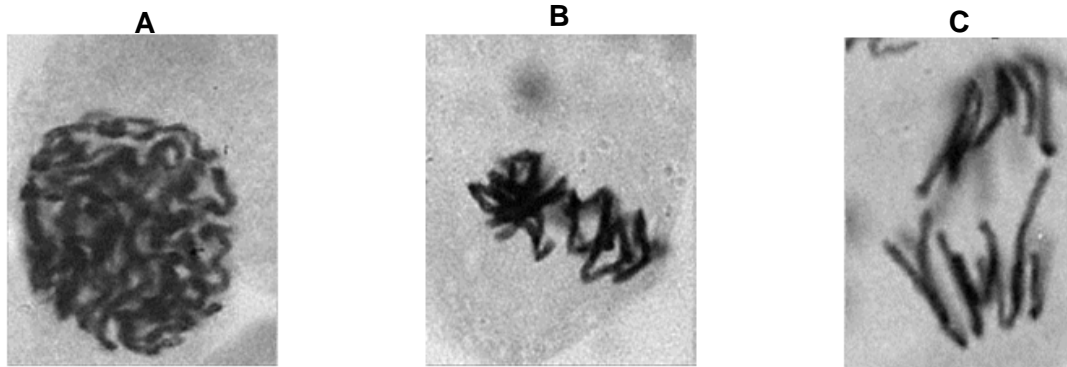


Fig. 1.2

(b)

- (i)** Identify stages of mitosis that cell **A** and **B** is undergoing.

.....[1]

- (ii)** State the visible features in cell **A** and **B** that enabled your identification in **(b)(i)**.

.....

.....

.....[2]

Fig. 1.3 shows the changes in the DNA amount during the meiotic cell cycle of the germ cells in zebrafish.

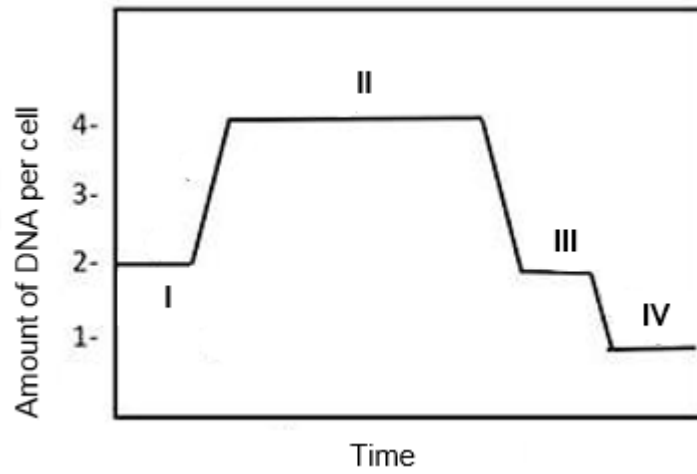


Fig. 1.3

(c) With reference to Fig. 1.3, explain the changes in DNA amount from stage II to IV.

.....

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.....[3]

[Total: 10]

2. In recent years, numerous biochemical and genetic studies have demonstrated that peptide signalling plays a greater than anticipated role in various aspects of plant growth and development. A substantial proportion of these plant peptides are secretory and act as local signals mediating cell-to-cell communication.

Fig 2.1 and Fig. 2.2 show two different membrane-bound organelles found in shoot apical meristematic cells.

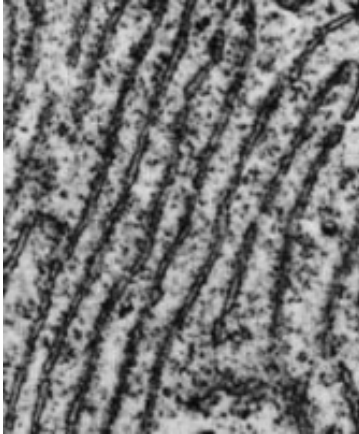


Fig 2.1



Fig. 2.2

- (a) Describe how the two organelles in Fig 2.1 and Fig. 2.2 work together in the production and secretion of plant peptides.

.....

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.....

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.....[3]

Fig. 2.3 shows the process of protein synthesis that takes place on the organelle shown in Fig. 2.1.

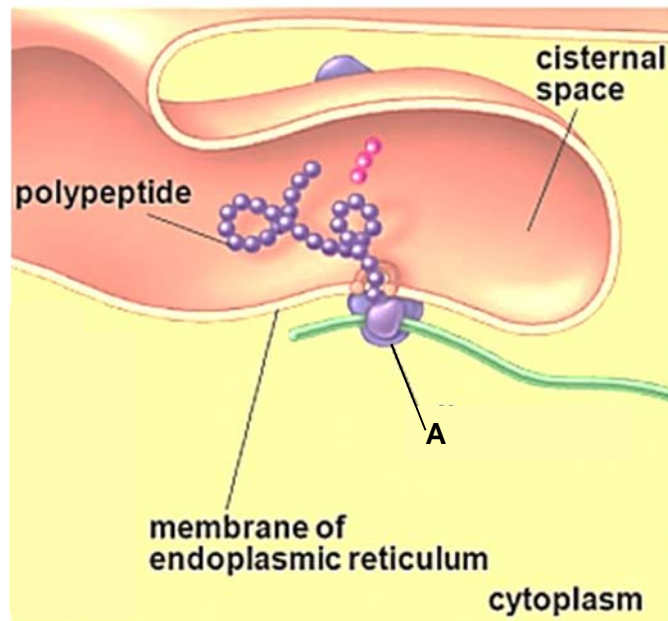


Fig. 2.3

(b) Describe how the structure of **A** is adapted to its role in the process shown in Fig. 2.3.

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.....[3]

Fig. 2.4 shows the role of tRNA in the process of protein translation while Fig. 2.5 shows the genetic code in terms of the mRNA codons sequence.

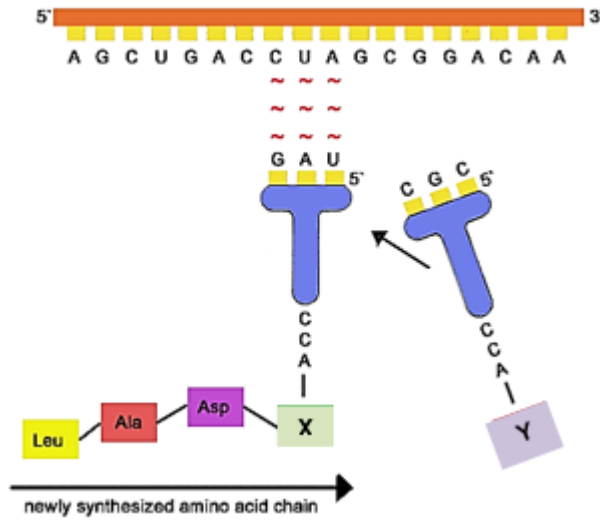


Fig. 2.4

		Second Letter					
		U	C	A	G		
1st letter	U	UUU Phe UUC UUA Leu UUG	UCU Ser UCC UCA UCG	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	3rd letter	U C A G
	C	CUU Leu CUC CUA CUG	CCU Pro CCC CCA CCG	CAU His CAC CAA CAG	CGU Arg CGC CGA CGG		U C A G
	A	AUU Ile AUC AUA AUG Met	ACU Thr ACC ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG		U C A G
	G	GUU Val GUC GUA GUG	GCU Ala GCC GCA GCG	GAU Asp GAC GAA Glu GAG	GGU Gly GGC GGA GGG		U C A G

Fig. 2.5

(c) With reference to Fig. 2.4 and Fig. 2.5, identify amino acid X and Y.

X:

Y:

[1]

The palisade mesophyll cells of plant contain numerous chloroplasts. Fig. 2.6 shows an electron-micrograph of a chloroplast in plant cell.

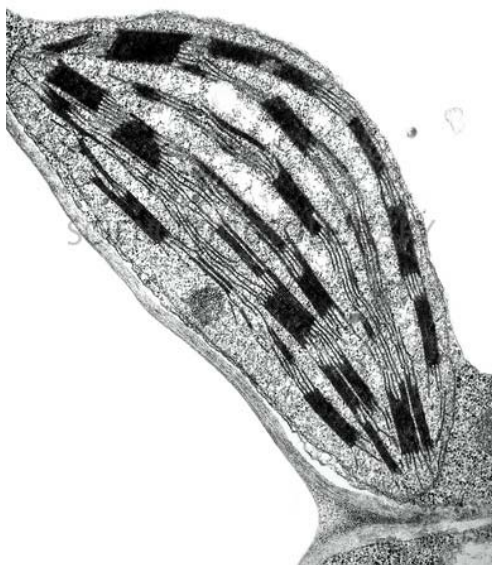


Fig. 2.6

(d) Draw an arrow and label the structure where light-dependent reactions occurs in the chloroplast. **[1]**

The rate of decolourisation of DCPIP in the Hill Reaction is a measure of the rate of the light-dependent stages of photosynthesis. DCPIP, a blue dye, acts as an electron acceptor and becomes colourless when reduced, allowing any reducing agent produced by the chloroplasts to be detected.

A suspension of chloroplasts was made by grinding fresh leaves in buffer solution and centrifuging the mixture. Tubes were then prepared and treated in the following way and the results of this investigation is shown in Table 2.1.

Table 2.1

Tubes	Content	Condition	Colour	
			Start	After 15 min
A	3 cm ³ chloroplast suspension 8 cm ³ DCPIP	Illuminated strongly	Blue-green	Green
B	3 cm ³ buffer solution 8 cm ³ DCPIP	Illuminated strongly	Blue	Blue
C	3 cm ³ chloroplast suspension 8 cm ³ DCPIP	Left in the dark	Blue-green	Blue-green

- (e) Using your knowledge of light-dependent reactions, account for the results shown in Table 2.1.

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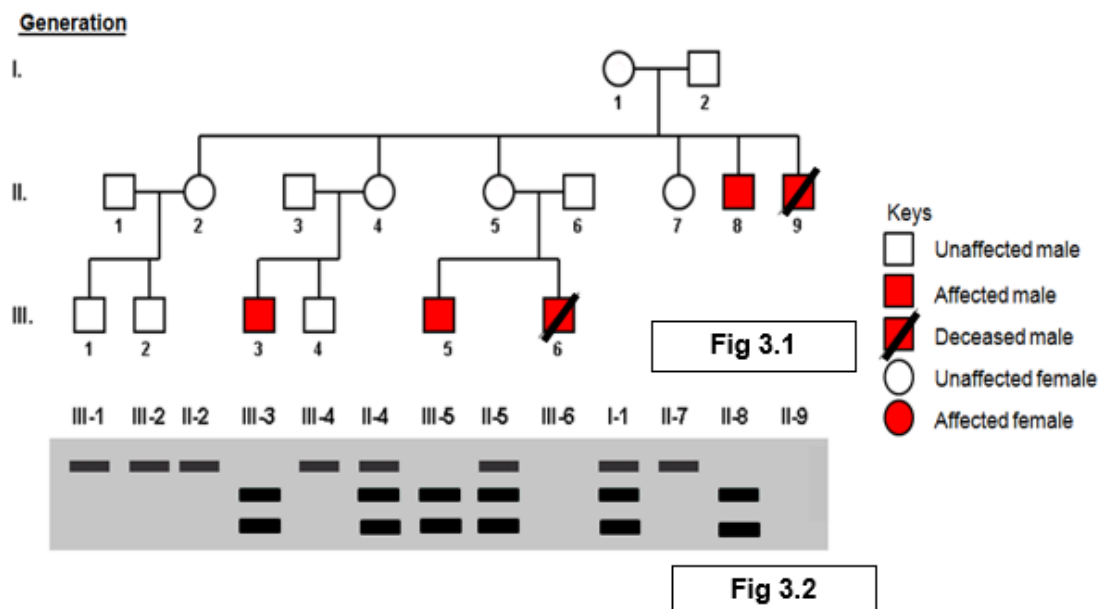
.....[4]

[Total: 12]

3. Haemophilia A, also called factor VIII (FVIII) deficiency or classic haemophilia, is a genetic disorder caused by missing or defective factor VIII, a clotting protein. This genetic disorder is characterised by episodes of internal and external bleeding in affected individuals.

According to the United States Centers for Disease Control and Prevention, haemophilia occurs in approximately 1 in 5,000 live births. There are about 20,000 people with haemophilia in the United States. All races and ethnic groups are affected.

Fig. 3.1 shows a pedigree of a family with history of haemophilia A. The FVIII gene was first isolated from each individual using Polymerase Chain Reaction (PCR). The PCR products were then digested using restriction enzymes and the resulting fragments separated by gel electrophoresis. Fig. 3.2 shows the results of the gel electrophoresis for some of the individuals.



- (a) With reference to Fig. 3.1 and Fig. 3.2, state two pieces of evidence that confirm that haemophilia A is an X-linked recessive disorder.

.....

.....

.....[2]

Individual II-3 and II-4 do not exhibit the symptoms of haemophilia A and they are heterozygous for both blood type A and B respectively. III-3, who is the son of II-3 and II-4, suffers from haemophilia A and has a blood type is AB.

- (b)** With reference to Fig. 3.1 and Fig. 3.2, construct a genetic cross diagram to explain how II-3 and II-4 can result in a child with haemophilia A and blood type AB.

[5]

[Total: 7]

4. MRSA is a variety of *Staphylococcus aureus*. It is difficult to treat infections caused by this type of bacteria because it is resistant to methicillin and to some other antibiotics. As a result, some patients who are already very ill may die if they become infected with MRSA.

- (a) Describe how natural selection makes MRSA resistant to the commonly used antibiotics.

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.....[4]

Antibiotic resistance genes have been employed widely in recombinant DNA technology to produce transgenic bacteria containing human genes.

To produce insulin for medical uses, human insulin genes are transferred into bacteria. Plasmids containing two antibiotic resistance genes, one coding for resistance to tetracycline and one for resistance to ampicillin, are used to carry out this transfer.

Table 4.1 shows the actions of four different restriction enzymes, which might be used in the production of a recombinant DNA molecule, and the source of these enzymes.

Table 4.1

Organism	Restriction enzyme	Target DNA sequences (cleavage sites shown by arrow linings)
<i>Escherichia coli</i> RY 13	<i>EcoRI</i>	5' G <u>↑</u> A A T T C 3' 3' C T T A A <u>↓</u> G 5'
<i>Bacillus amyloliquefaciens</i>	<i>BamHI</i>	5' G <u>↑</u> G A T C C 3' 3' C C T A G <u>↓</u> G 5'
<i>Providencia stuartii</i>	<i>PstI</i>	5' C T G C A <u>↑</u> G 3' 3' G <u>↓</u> A C G T C 5'
<i>Haemophilus influenzae</i>	<i>HindII</i>	5' G T Py <u>↑</u> Pu A C 3' 3' C A Pu <u>↓</u> Py T G 5'

- (b) With reference to Table 4.1, explain why *EcoRI*, *BamHI* and *PstI* are more suitable for use in the cloning of human insulin gene than *HindII*.

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.....[2]

After the fragments of human DNA and the cut plasmids were mixed together, several types of plasmid were formed. The different types of plasmid are shown in Fig 4.1.

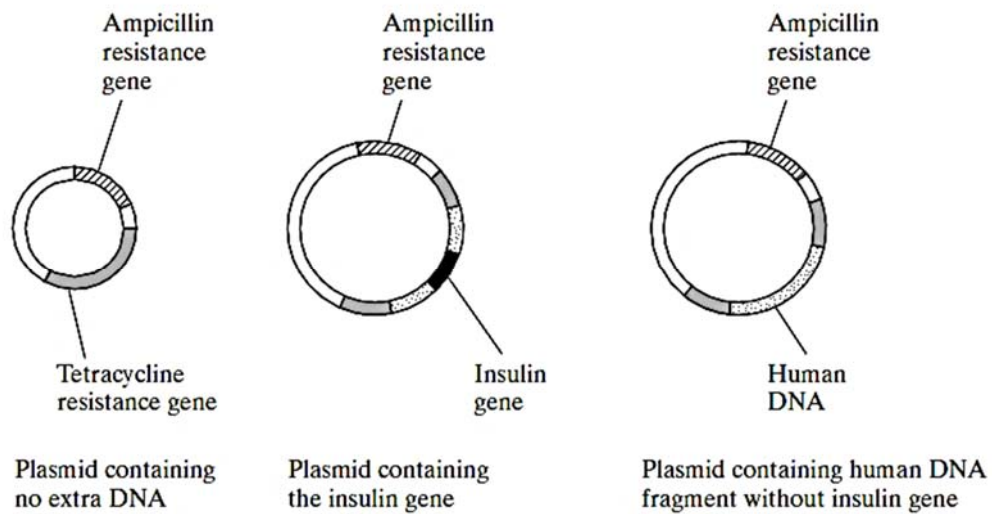


Fig 4.1

- (c) State another property of the plasmid not shown in Fig. 4.1 that enables it to be used as a cloning vector.

.....[1]

- (d) Explain how it is possible to distinguish between bacteria, which have taken up a plasmid with human DNA and those, which have taken up a plasmid without any extra DNA.

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.....[4]

[Total: 11]

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) Compare the structure and role of deoxyribonucleic acid and ribonucleic acid. **[6]**

(b) Using named examples, explain how anatomical, embryological and molecular homology supports Darwin's theory of natural selection. **[7]**

(c) Using named examples, discuss the importance of genetic engineering in solving the global demand for food. **[7]**

[Total: 20]

6.

(a) Relate the structure of haemoglobin to its function in animals. **[6]**

(b) Explain the small yield of ATP produced by anaerobic respiration in mammals. **[6]**

(c) Restriction digest is usually performed prior to agarose gel electrophoresis.

With reference to the principles of gel electrophoresis, discuss why the incubation time for restriction digest of the plasmid DNA is important in obtaining accurate results from gel electrophoresis. **[8]**

[Total: 20]

End of Paper