Name	Subject Class	Class	Candidate Number
	2BIX01		

ANGLO-CHINESE JUNIOR COLLEGE
Preliminary Examination 2016

BIOLOGY **8875/02**
22 AUGUST 2015
HIGHER 1 **2 hours**

Paper 2

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	
Section B	
4 or 5	
Total	**60**

This question paper consists of **9** printed pages.

[Turn over

For examiner's use

1 The mitotic cell cycle in the somatic cells of a diploid organism can be followed by measuring the number of chromosomes as well as the amount of DNA material per cell over a period of time. Fig. 1.1 shows the results of the analyses, beginning with the start of mitosis.

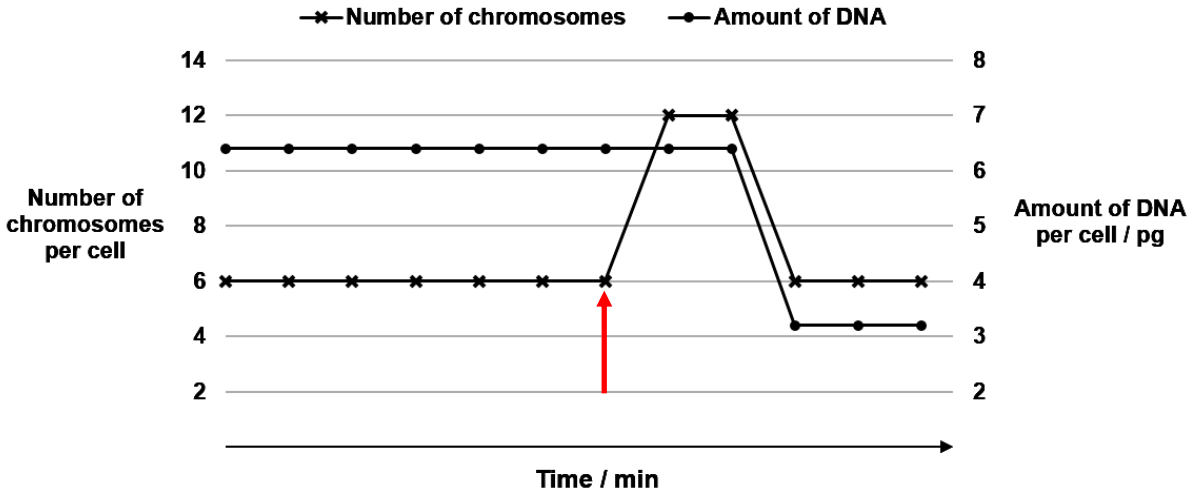

Fig. 1.1

(a) (i) Indicate, using an arrow in Fig. 1.1, the point where anaphase begins. [1]

Indicated as red arrow above;

(ii) Explain your answer provided in (a)(i).

1. **Prior to anaphase, each chromosome is comprised of two sister chromatids held at the centromere;**
2. **During anaphase, the centromere divides and spindle fibres pull the sister chromatids to opposite poles of the cell;**
3. **Separated chromatids are now regarded as individual chromosomes;**
4. **Hence, number of chromosomes per cell doubles from 6 to 12;**

@ 1m

[3]

(iii) Explain how the results of the analyses might be different if a cell undergoing the meiotic cell cycle is measured instead.

1. **Number of chromosomes per daughter cell would be further halved to 3;**
2. **Amount of DNA per daughter cell would be further halved to 1.6 pg;**
3. **Since meiosis is a reduction division where the ploidy level / number of sets of chromosomes is halved OR meiosis leads to the formation of haploid gametes with half the number of sets of chromosomes;**

@ 1m

[3]

Fig 1.2 shows the karyotype of a different diploid organism, where the chromosomes are arranged in matching pairs.

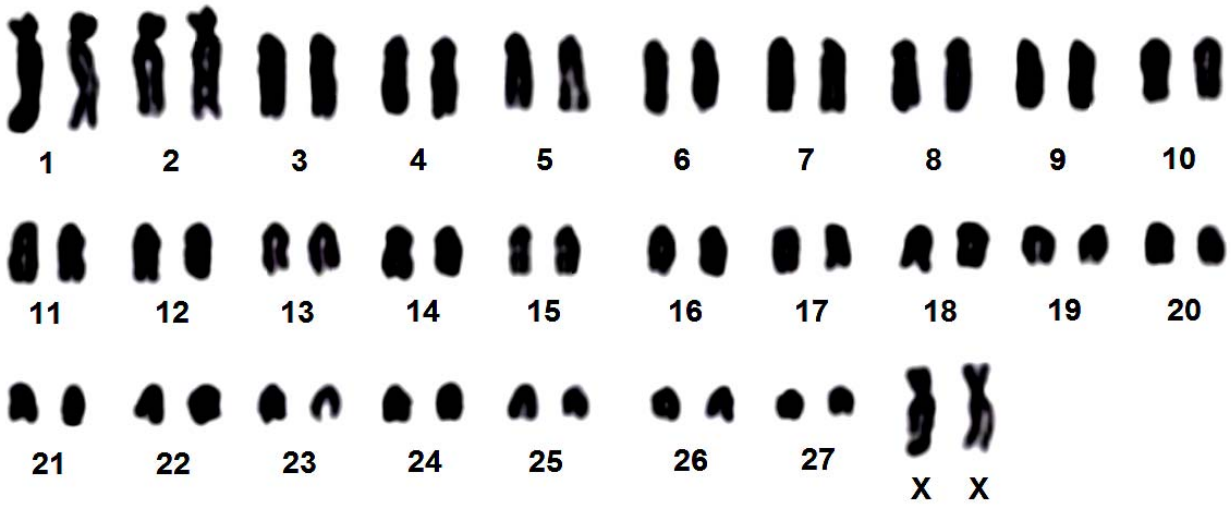

Fig. 1.2

(b) (i) Describe how the appearance of DNA in early interphase will differ from those in Fig. 1.2.

1. **DNA molecules would exist singly in early interphase, as compared to that in Fig. 1.2 where sister chromatids are joined together at the centromere;**
2. **DNA molecules would also exist as loose chromatin threads, as compared to that in Fig. 1.2 where they appear as condensed chromosomes;**

@ 1m

[2]

(ii) Outline the processes that will account for these differences described in (b)(i).

(iii)

1. **Semi-conservative replication of DNA during S phase of interphase will occur to form genetically-identical sister chromatids;**
2. **Where both parental strands of each DNA molecule serve as templates for the synthesis of daughter strands;**
3. **Chromatin threads condense during prophase to form chromosomes;**
4. **By forming tightly coiled structures with the help of histone (and scaffold) proteins;**

@ 1m

[4]

[Total: 13m]

2 Fig. 2.1 shows an electron micrograph of a chloroplast in a plant cell.

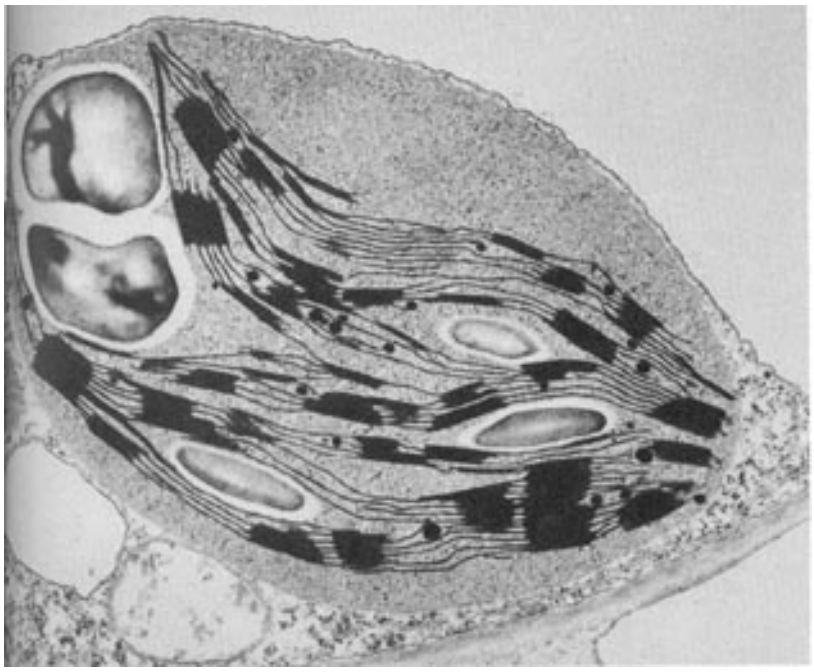

Fig. 2.1

(a) (i) Indicate clearly on Fig. 2.1 where photophosphorylation occurs. [1]

Arrow pointing to thylakoid membrane; @ 1m

(ii) Describe one way on which the structure indicated in (a)(i) is adapted for photophosphorylation.

1. Internal membrane system present large surface area;

2. for embedding a high number of photosystems, ATP synthase and electron carriers,

OR

3. Thylakoid membranes are impermeable to protons;

4. which allows for the formation of a proton gradient for chemiosmotic ATP synthesis; @ 1m [2]

Fig. 2.2 shows how a seed undergoes germination to form a seedling.

Fig. 2.2

(b)(i) In some pea plants, the respiratory quotient (RQ) has been found to be around three to four at the start of germination. Suggest a reason to explain the high RQ obtained at the early stages of germination.

1. **RQ is the ratio of carbon dioxide given out to oxygen taken in during respiration;**
2. **The testa or seed coat still covers the seed/seed embedded deep in the soil, making it difficult for oxygen to penetrate inside;**
3. **Respiration in seed is partly anaerobic (hence, the RQ > 1);** **@ 1m** [3]

(ii) Following root growth, leaves will develop and this is necessary for the seedling to harvest energy from the sun, Light intensity plays a role in determining the rate of photosynthesis. Explain the effect of light on the rate of photosynthesis at low light intensity.

1. **At low light intensity, the rate of photosynthesis (PTS) increases linearly with increasing light intensity;**
2. **More photosystems are photoactivated, leading to a higher rate of photophosphorylation;**
3. **A higher rate of photophosphorylation results in (more O_2 formed by photolysis as well as) the formation of more ATP and reduced NADP;**
4. **leading to a higher rate of the Calvin cycle/more CO_2 being accepted by RuBP , resulting in higher rate of formation of GALP;**

@ 1m [4]

(iii) Both the Calvin and Krebs cycles occur in a plant simultaneously. Contrast the two processes.

	Calvin Cycle	Krebs Cycle
Nature of reactions	**1. Anabolic reaction / glucose or GALP formed;**	**Catabolic reaction / acetyl CoA oxidised;**
Process in plant	**2. Occurs during photosynthesis**	**Occurs during aerobic respiration**
Location	**3. Occurs in the stroma of chloroplasts**	**Occurs in the matrix of mitochondria;**
ATP involvement	**4. Uses (3 molecules of) ATP (per cycle)**	**Produces (1 molecule of) ATP (per cycle via substrate level phosphorylation);**
Initial substrate / reaction	**5. CO_2 enters the Calvin cycle as initial substrate / CO_2 binds with RuBP as initial step in Calvin cycle**	**acetyl CoA (2C) enters the Krebs cycle as initial substrate / acetyl CoA binds with OAA as initial step in Krebs cycle;**
Role of CO_2	**6. CO_2 used / carboxylation of RuBP**	**CO_2 released / decarboxylation occurs;**
Oxidative carboxylation	**7. Intermediate does not undergo oxidative decarboxylation**	**Intermediate undergo oxidative decarboxylation;**
Redox reaction	**8. Intermediates (GP) are reduced/ Oxidation of H carrier**	**Intermediates (α-ketoglutarate/ Succinate/ Malate) are oxidized / Reduction of H carrier**
Regeneration of compounds	**9. (5C) RUBP regenerated**	**(4C) OAA regenerated;**
Hydrogen carriers	**10. No FAD is involved / Only NADP+ involved**	**$FADH_2$ produced / NAD and FAD involved**
Factors affecting the cycle (gases)	**11. Calvin cycle cannot occur in the absence of CO_2**	**Krebs Cycle cannot occur in the absence of O_2**
Factors affecting the cycle (light)	**12. Occurs only when light reaction occurs;**	**Does not require light;**
Purpose	**13. for the regeneration of RuBP and formation of sugars;**	**for the production of reduced H carriers (for the transport of H to ETC) for synthesis of ATP;**

@ 1m, max 3

[Total: 13m]

3 **(a)** Fig. 3.1 below shows a plasmid and the features found on it. *Nde I* is the position of the restriction site on the plasmid.

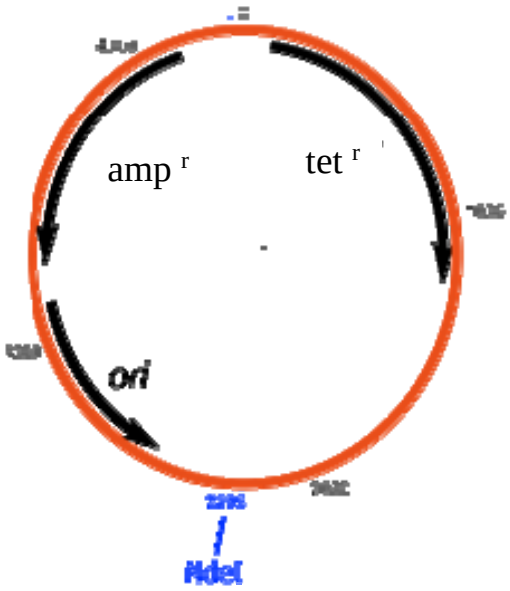

Fig. 3.1

(i) Explain the natural function of restriction enzymes.

1. To digest foreign DNA at specific restriction sites;
2. To protect bacteria from infection by virus;

[2]

(ii) With reference to Fig.3.1, explain if this plasmid can be used as a vector to clone genes of interest in bacteria.

1. Yes it can be used to clone genes in bacteria;
2. It contains restriction *(NdeI)* site that allows the plasmid to be digested for the insertion of gene of interest.
3. It contains a origin of replication that allows independent replication apart from the main chromosome;
4. It contains a marker gene (amp^r / tet^r) that can be used for selection of bacteria that have taken up the recombinant plasmid;

[4]

(iii) Explain the limitation in the use of this plasmid for the purpose of gene cloning in bacteria.

1. There is no restriction site present in any of the marker gene / amp^r / tet^r;
2. Hence bacteria that took up the recombinant plasmid cannot be distinguished from those that took up the reannealed plasmid.
3. Through the use of replica plating with antibiotic;

4. **A gene probe that is complementary to inserted gene has to be (synthesized and) used instead;**

[4]

(b) Explain the goals of genetic modification of organism.

1. **Increase quality and yield of food for increasing world population;**

[1]

(c) The GM Atlantic salmon is modified to carry a growth hormone gene from the Pacific Chinook salmon with an active promoter from the Oceanic Pout. The result is an active growing GM Atlantic salmon all year round, greatly reducing the time it takes for the salmon to reach market size. The GM Atlantic salmon is made sterile so that it cannot interbreed with other fish in the wild.

Suggest reasons why the genetically modified salmon is prevented from interbreeding with other fishes in the wild?

1. **It is to prevent the artificial gene construct from being passed on to wild salmons.**
2. **As effects of gene construct / foreign protein may not be known on other fishes;**
3. **Potential effects on disrupting food chain;**
4. **Fishes that inherit gene will out compete wild type species;**
5. **Inheritance of gene construct by wild fishes through interbreeding cannot be reversed once started;**

[3]

[Total: 14m]

For examiner's use

Section B

Answer **EITHER 9 OR 10**.

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

9 **(a)** Using the induced-fit hypothesis, explain the mode of action of enzymes. [6]

1. **Enzyme lowers activation energy;**
2. **Ref. to *mechanisms e.g. 'proximity effect', 'strain effect' and 'orientation surface'***
3. **Enzyme <u>specific</u> in its action due to <u>complementary</u> 3D configuration/conformation of active site to that of substrate;**
4. **The induced fit model suggests that the enzyme and the substrate do not fit together exactly;**
5. **<u>Effective</u> collisions between enzymes and (specific) substrate molecules result in substrate binding to active site of enzyme;**
6. **The enzyme undergoes a 3D conformation change, which improves the fit between substrate and enzyme;**
7. **to form enzyme-substrate (ES) complexes;**
8. **Product formed that no longer fits into active site and is released;**
9. **Enzyme remains unchanged at the end of the reaction and can be reused;**

(b) With reference to haemoglobin, explain the significance of bonds in maintaining the protein's structure and function. [8]

1. **Peptide bonds between amine groups and carboxyl groups of amino acids at primary structure of organisation, hydrogen bonds between –CO and –NH groups of the polypeptide backbone;**
2. **Ref. to overall 3D configuration/ globular shape of haemoglobin;**
3. **Each globin polypeptide is folded such that the bulk of the hydrophobic amino acid residues are buried in the interior of the globular structure;**
4. **Ref. to haem binding pocket lined with hydrophobic amino acids to provide a hydrophobic environment for hydrophobic haem group to bind;**
5. **Hydrophilic amino acid residues are on the outside;**
6. **Haemoglobin is soluble in aqueous medium and hence a good transport protein for oxygen in blood;**
7. **The two polypeptide chains in each dimer are held together by mainly hydrophobic interactions;**
8. **The two dimers are held together by weak hydrogen and ionic bonds;**
9. **Resulting in the ability of the two dimers to move with respect to each other;**
10. **This allows for cooperativity;**
11. **When an oxygen molecule binds to/is released from 1 haemoglobin subunit, the binding/ release induces a conformational change in the remaining subunit;**
12. **Which increases/ lowers the affinity for oxygen of the remaining three oxygen binding sites respectively;**
13. **This facilitates the loading and unloading of oxygen;**

(c) Compare competitive and non-competitive inhibition of enzyme action. [6]

Features	Competitive	Non-competitive
Structure of inhibitor	**Resembles substrate;**	**Does not resemble substrate;**
Binding site of inhibitor	**Binds to active site of enzyme;**	**Binds to enzyme at a region other than the active site;**
Mechanism of inhibition	**Blocks substrates from binding to active site of the enzyme;**	**Blocks substrates from binding to active site by changing the conformation of the active site;**
Effect of high substrate concentration on inhibition	**Inhibition can be reversed at high substrate concentration;** **V_{max} in the presence of inhibitor can be very close to that of reaction in the absence of inhibitor;**	**Inhibition cannot be reversed at high substrate concentration;** **V_{max} in the presence of inhibitor is less than that of reaction in the absence of inhibitor;**
Similarities: **1. At low substrate concentration, rate of reaction in the presence of inhibitors is slower than that in the absence of inhibitor;**		

[Total: 20m]

OR

10 (a) Describe the fluid mosaic model of membrane structure and how this model explains the movement of substances across the cells. [6]

1. Fluid refers to both the phospholipids and proteins being free to move within the membrane due to phospholipids held together by hydrophobic interactions;

2. Mosaic refers to the scattered manner in which membrane proteins are embedded in the membrane;

3. Phospholipids form hydrophobic core which allows small, non-polar substances to diffuse across membranes;

4. Fluidity enables invagination of membrane during endocytosis, allowing large substances to be taken into cells;

5. Fluidity enables fusion of vesicle membrane with cell surface membrane during exocytosis, allowing substances to be released out of the cell;

6. Presence of proteins allow hydrophilic substances to move across cells via active transport/ facilitated diffusion;

@ 1m

(b) Outline the roles of lipids in membranes. [8]

Roles of phospholipids:

1. Phospholipids held by weak hydrophobic interactions allow membrane to be fluid;

2. To be selectively permeable;

3. For the membranes to fold or fuse during exocytosis and endocytosis;

4. For membrane proteins to be embedded and to function normally;

5.Hydrophobic hydrocarbon core allows non-polar molecules to diffuse through/ prevents hydrophilic/ polar/ charged molecules to pass through;

Role of cholesterol:

6. At relatively higher temperatures, cholesterol makes the membrane less fluid by restraining phospholipid movement;

7. At lower temperatures, cholesterol hinders the close packing of the phospholipids and so prevents the membrane from solidifying;

Role of glycolipids:

8. Cell-cell recognition;

9. Cell-cell adhesion;

@1m

(c) Describe the functions of membranes in cells. . [6]

1. The cell surface membrane separates the cytoplasm from the external environment;

2. Membranes act as selective barriers to regulate passage of substances in and out of the cell and organelles/ Membrane proteins allow the transport of hydrophilic molecules across the membrane;

3. Increase surface area for exchange of substances eg. the microvilli found in the cells lining the small intestine for absorption of food substances;

4. Increase surface area for attachment of proteins for specific functions eg. chlorophyll molecules in thylakoid membranes for light absorption/ electron carriers & ATP synthase in thylakoids (of chloroplasts) and cristae (of mitochondria) for ATP synthesis;

5. Cell-cell recognition by glycoproteins/ glycolipids;

6. Membrane proteins form receptors with a binding site that only the specific hormone or foreign substance can recognise and bind to;

@1m

[Total: 20m]