



**TEMASEK JUNIOR COLLEGE
PRELIMINARY EXAMINATION
JC 2/ IP YEAR 6 2017**

CANDIDATE
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H1 BIOLOGY

Paper 2 Structured Questions

8875/02

Tuesday 12 September 2017

2 hours

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number, index number and class in the spaces at the top of the page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graph.

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

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

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.

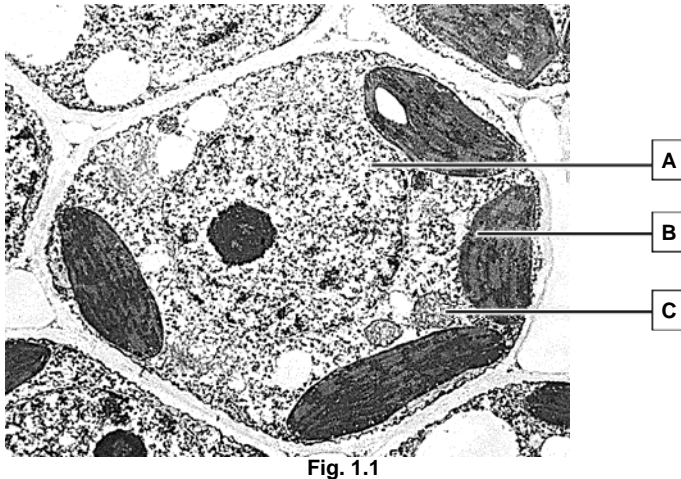
For Examiner's Use	
Paper 1	/30
Paper 2	/60
Q1	/12
Q2	/13
Q3	/15
Essay	/20
Total	/90

This document consists of **12** printed pages.

Section A

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

- 1 Fig. 1.1 shows an electron micrograph of a plant cell.



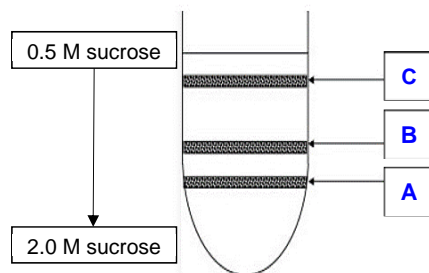
- (a) Identify organelles **B** and **C**.

Organelle **B**: Chloroplast [1]

Organelle **C**: Mitochondrion [1]

- (b) Extracts from the homogenised plant cells in Fig. 1.1 were added to a sucrose density gradient and centrifuged at high speed to separate the various organelles.

- (i) Label the bands where organelles **A**, **B** and **C** can be found after centrifugation.



[3]

(ii) Explain your answer in (b)(i).

[2]

1. **Density gradient**
2. **Organelles will separate according to their densities.**
3. **Nucleus - heaviest**
Chloroplast - medium size
Mitochondria – smallest size

In a separate experiment, protoplasts (plant cells with cell wall removed) were first treated with three different reagents – ethanol, distilled water and buffer solution, for two hours. The treated cells were then subjected to the density gradient centrifugation.

Fig. 1.2 shows the thickness of the lowest band for each type of treated cell after density gradient centrifugation.

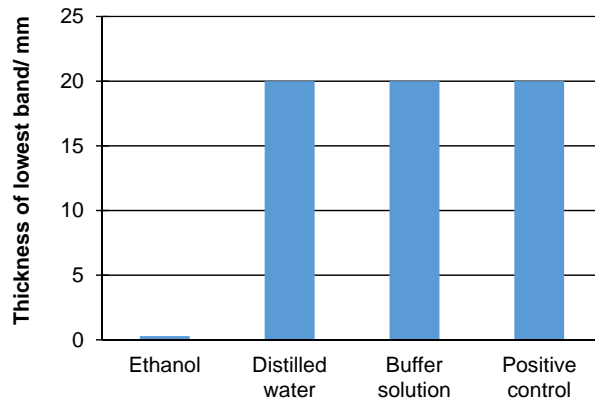


Fig. 1.2

(c) Explain the effects of the different reagents on the thickness of the lowest band. [3]

- **0mm Ethanol – organic solvent – dissolves phospholipid bilayers thus no intact organelles (nucleus) can be obtained.**
- **0mm Distilled water - Net movement of water molecules into nucleus,**
 - **It has double membrane, therefore remained intact.**
- **20mm Buffer solution –no net movement of water molecules, thus intact nucleus**

Fig. 1.3 shows another component found in animal cell membranes.

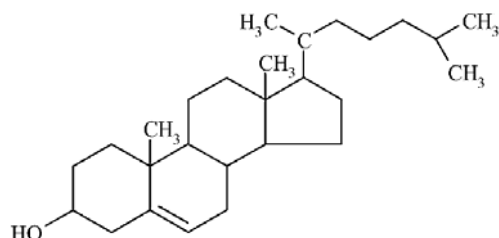


Fig. 1.3

(d) Explain how the **molecule** shown in Fig. 1.3 performs its function in **cell membranes**. [2]

1. At higher temperatures cholesterol reduce membrane fluidity.
2. At lower temperatures cholesterol helps prevent membranes from freezing by disrupting the close packing of phospholipids.

[Total: 12]

2 (a) Explain why **mRNA** is formed as a **continuous strand** during transcription while **one of the DNA strands** is formed **discontinuously** during replication. [3]

1. DNA and RNA polymerases synthesize the new strands in the 5'→3' direction.
2. template for DNA replication is double-stranded and anti-parallel, while template for mRNA synthesis is single-stranded.
3. the direction of unwinding of the DNA template occurs opposite to the direction of synthesis for the lagging strand.

(b) Outline the **process** of **transcription**. [3]

1. General Transcription Factors bind to TATA box and promoter
2. Recruit the RNA polymerase to form the Transcription Initiation Complex (TIC).
3. RNA polymerase separate the two strands
4. RNA polymerase synthesizes the RNA in the 5'→3' direction
5. Free ribonucleotides form base pairs with the template strand.
6. Phosphodiester bonds formed between adjacent ribonucleotides
7. RNA polymerase transcribes the termination and polyadenylation signal
8. pre-mRNA is cut and released from the polymerase.
9. The DNA winds to re-form the double helix.

Several types of rRNA and tRNA are transcribed as a single strand precursor RNA. Following transcription, each rRNA (16S, 23S, 5S) and tRNA molecule is cleaved in a process known as RNA trimming to form mature rRNA and tRNA molecules, as shown in Fig. 2.1.

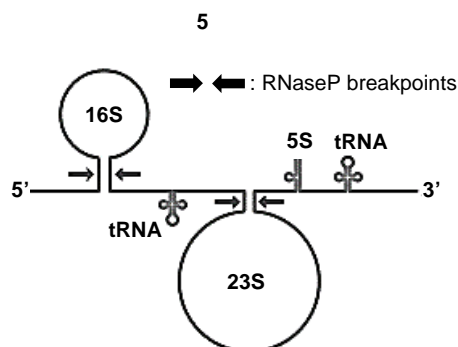


Fig. 2.1

- (c) State where **rRNA genes** are **found**. [1]
Nucleolus/ Mitochondria/ Chloroplasts
- (d) Compare the process of **RNA trimming** and **post-transcriptional modification** for mRNA. [2]
1. (Difference) **Trimming** – rRNA and tRNA are formed from a pre-RNA strand, whereas **post-transcriptional modification** for mRNA – only mature mRNA formed from pre-mRNA.
 2. (Difference) **RNaseP** is involved in trimming, whereas **splicing** involves spliceosome.
 3. (Similarity) both processes involve the removal of segments (e.g. intron for pre-mRNA) that are not required.
- (e) Relate how the **single-stranded structure** of **rRNA** and **tRNA** facilitates their **roles**. [4]
1. **Single stranded structure** –allow bases to fold back upon themselves, held in shape by hydrogen bonds between complementary base pairs
 2. **rRNA** - formation of the small ribosomal subunit, and the large ribosomal subunit.
 3. **tRNA** – formation of a structure that can fit into the E, P, A sites found on the large ribosomal subunit.
 4. Allows complementary base pairing of its anticodon with the codon of mRNA during translation to ensure that the correct sequencing of amino acids on the polypeptide chain.

[Total: 13]

- 3 Anole lizards are found throughout the Caribbean and the surrounding mainland. An investigation was carried out to determine the relationships between these lizard species using DNA analysis. Fig. 3.1 shows a continuous part of the base sequence of a region of DNA that is read in the 5' → 3' direction. The base number of the first nucleotide of each row is shown on the left of the sequence.

001	TTTTTTTGT	CATGCTGTGT	CTTCTGGACT	GCAATACTAT	ATCTGCTAGA
051	ATGATTTC	TGGGTAACGA	TGTCCCCTGG	ATCCTGATT	TTGCCGTTCT
101	CCCAAATTCT	GGTTGTATTA	AATGCTGTAA	ATGTCTCCAT	AACATGTCTC
151	ATTGCTATAC	CATGTCTCCC	AAAACCCAAT	TTGTTCATAT	TATGTACCCA
201	AGACTCTGGT	ACTATGTTTC	CTGGGGCATA	ATTTTGGCAC	AATCTCTCTC
251	CCTCGCCCTG	TTCCTGCAG	GAAAGTATGG	TGCCTTGGAT	GCGGGGGCTC
301	TGCTGGCGCT	GCTGCCACTA	ACGGAAGACC	AGGAGAGCAA	GGTGCGCCTC
351	TATGCCCTGA	AGGCTCTGAC	TGTCTTGGCT	GTATTTCGTAC	GAGACCCAGT
401	ACCCCTCCTG	CCCCACATCC	CTCTGCTGCA	GGAGCGCAGC	CAGGATCCCA

Fig. 3.1

- (a) Design two 12bp long primers X and Y that can be used to amplify the sequence that spans from nucleotide 052 and 392.

Primer X: Forward primer: 5' TGATTTCGTTGG 3'

Primer Y: Reverse primer: 3' CATAAGCATGCT 5' [2]

Fig. 3.1 shows the phylogenetic relationships among Anole lizards. The results from gel electrophoresis of amplified *rtadr1y* and *kank1* sequences are also shown.

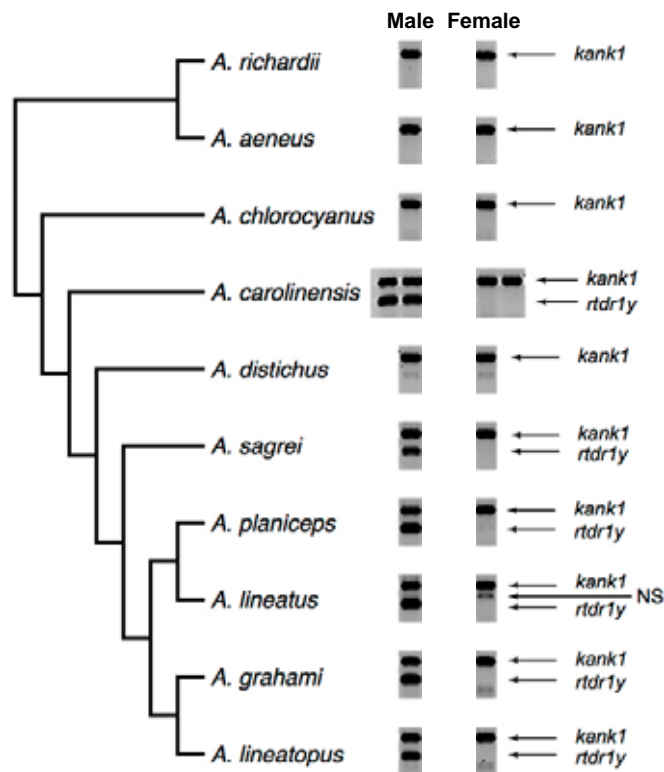


Fig. 3.1

- (b) Explain which type of chromosome *rtdr1y* sequence is found on. [2]
1. Y chromosome
 2. as the BAND is only found in the males.

Commented [OKE1]: State the type of chromosome on which the *rtdr1y* sequence is found on.

The phylogenetic relationship between organisms is typically established through the use of *cytochrome c* gene, which is encoded in the nuclear DNA.

- (c) Explain why *cytochrome c* gene is used for phylogenetic studies. [3]
1. highly conserved gene, important function in aerobic respiration.
 2. Any mutation would result in a non-functional protein that cause death of organisms.
 3. Thus, comparison of sequences non-essential for the survival of the organism is conducted for phylogenetic studies.

Fig. 3.2 shows the process in which cytochrome c is involved in.

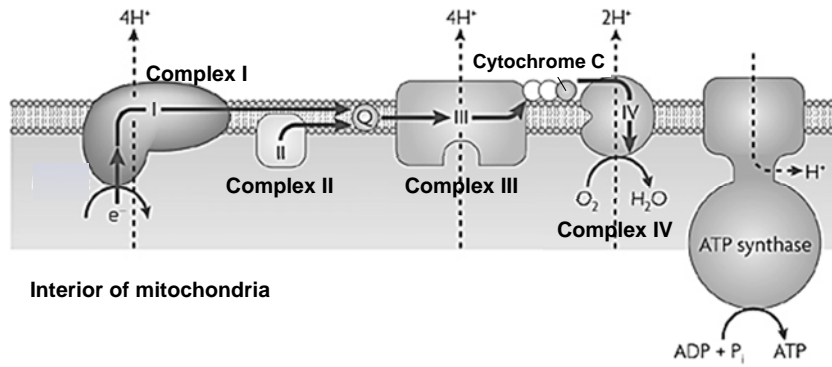


Fig. 3.2

- (d) Explain the significance of cytochrome c in the process shown. [3]
1. an electron carrier
 2. flow of electrons down the ETC
 3. The energy released from the
 4. is used to create a steep proton gradient across the inner mitochondrial membrane.
 5. to drive ATP synthesis via ATP synthase in a process known as chemiosmosis.

Anole lizards are found in different ecological niches throughout the Caribbean and the surrounding mainland as shown in Fig. 3.3. Each species is found only on one island or a small group of islands, apart from *Anolis carolinensis* which is found in mainland Florida.

Some species live on twigs, others in the trunk, and others in the grass. Species that live on twigs have long tails and short legs; species that live in the grass have short tails; and species that live on low tree trunks have long legs. The species that live on twigs all look similar, whether they are the species from Cuba, Hispaniola, Jamaica, or Puerto Rico.

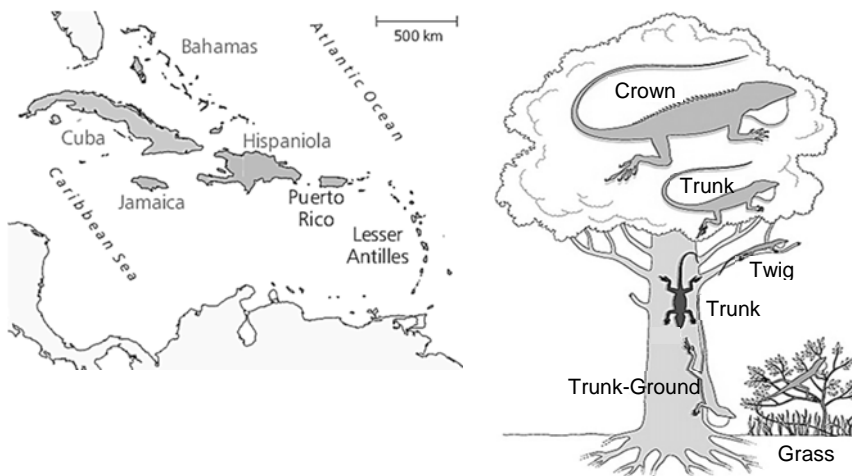


Fig. 3.3

Fig. 3.4 shows phylogenetic relationship of *Anolis* found in different ecological niches on four Caribbean islands.

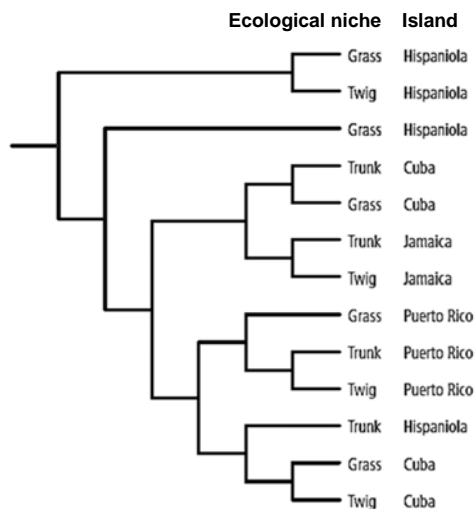


Fig. 3.4

(e) Explain how the different species of lizards that are morphologically similar might have arisen in different islands.

1. Ref to leg and tail lengths due to genetic variation in the lizards
2. different islands that has different selection pressures.
3. Lizards that have the favourable alleles that confer longer legs were able to escape from their predators
4. survive till reproductive age and reproduce to produce viable and fertile offspring,
5. Thus, the frequency of favourable alleles would increase.,
6. the lizards do NOT interbreed with one another.
7. As the different islands have similar habitats,
8. the lizards in different islands evolve independently, thus they look morphologically similar.

[Total: 15]

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

EITHER

- 4 (a) Discuss the **pros** and **cons** of using **embryonic stem cells** in **medical research**. [7]

Source of ESC

1. ESC are derived from the inner cell mass (ICM) of the blastocyst from excess embryos produced during *in vitro* fertilisation (IVF) procedures.

Pros

2. ESC are pluripotent.
3. Able to differentiate into almost any cell type to form any organ or type of cell
4. Thus, development of tissues or organs can be studied.
5. capable of dividing and self-renewal for long periods

Cons

6. disagreement on moral status of embryo.
7. No moral status : ball of cells that cannot survive outside the womb, no bodily characteristics, is not conscious and cannot feel anything.
8. same moral status as a human being: potential to become a living, viable human being.
9. using embryonic stem cells for scientific research is tantamount to killing a life.
10. Religious objection
11. Disrespect for the value of human life.
12. De-sensitization to the destruction of human life.
13. Alternatives such as induced pluripotent stem cells.
14. Unable to form the extra-embryonic membranes or the placenta.

- (b) Using **Bt corn** as an example, discuss the **potential benefits** and **issues** of genetically modified crops. [8]

Benefits [4]

1. insertion of a gene from *Bacillus thuringiensis* into the corn
2. which produces the protein Bt delta endotoxin.
3. Kills the common pest European Corn Borer that destroys corn crops.
4. Endotoxin is extremely selective, only kills certain insects. Thus, there is no need to spray insecticides on their crops to get rid of the pests.
5. Endotoxin is considered safe for human consumption.
6. Farmers can save money on the purchase of insecticides,
7. increase their crop yields and productivity,

Safety considerations

1. However, a 2009 study has found that rats fed with genetically modified corn had problems with the liver, kidneys, heart, adrenal glands and spleen.

2. Therefore, no conclusive studies that prove human consumption of Bt corn is indeed safe.
3. genes for antibiotic resistance in vector may be transferred from the transgenic plant to other bacteria, making them antibiotic-resistant.

Possible threats to environment

4. The caterpillars that feed on milkweed plants that contain Bt corn pollen are more likely to have lower survival rates.
5. spread of pesticide resistance to weeds.

Legal issues

6. patents for the Bt corn and its seeds,
 - a. farmers who distribute and share Bt corn seeds may be sued for patent infringement or be exposed to other legal challenges.
 - b. farmer B who have Bt corn in their fields though they did not "purchase" the Bt corn seeds may be sued.

Financial issues

7. Farmers are now dependent on the biotech companies for a continuous supply of seeds. This can be very expensive.

(c) Describe the natural and applied roles of restriction enzymes. [5]

1. Restriction enzymes are enzymes with active site that recognizes and binds to restriction site, that is palindromic in sequence and
2. hydrolyzing the phosphodiester bond between two specific nucleotides.
3. protect bacteria from viruses by degrading incoming viral (foreign) DNA.

Applied Roles

4. A specific restriction enzyme is used to cut the DNA molecule which contains the gene of interest.
5. The same restriction enzyme is used to cut the plasmid vector.
6. The complementary sticky ends of restriction fragments anneal spontaneously to form recombinant DNA.
7. Restriction enzymes digest DNA samples to create restriction fragments for DNA fingerprinting,
8. fragments are separated based on size in gel electrophoresis.

[Total: 20]

Commented [OKE2]: 2015/MCT/H1/P2/Q5c
Describe, with a named example, the natural and applied uses of restriction enzymes. [7]

Natural uses

1. Example EcoRI, BamHI, SmaI, etc
2. Restriction enzymes are synthesized naturally in bacteria to protect the bacteria from viruses
3. by degrading incoming viral (foreign) DNA.
4. Each restriction enzyme recognizes and binds to a specific sequence of 4 to 8 nucleotides on viral DNA molecule called a restriction site (Must have mentioned virus in either point 2, 3, or 4)
5. by hydrolyzing the phosphodiester bond at a position between two specific adjacent nucleotides.
6. The bacterial genome is protected from the action of the restriction enzyme by methylation.
7. where a methyl (-CH₃) group is added to an Adenine or Cytosine base at the restriction sites.

Applied uses

8. allow formation of recombinant DNA;
9. RE is used to isolate DNA or gene of interest from organism DNA;
10. The same RE is used to cut plasmid/vector.
11. Restriction fragments produced by restriction enzymes can have sticky ends or blunt ends.
12. RE recognizes the palindromic restriction sites to generate complementary sticky ends for the formation of recombinant DNA.
13. Sticky ends allow cut DNA fragments to anneal spontaneously by forming hydrogen bonds with complementary sticky ends of DNA fragments cut up by the same enzyme.
14. Blunt ends make annealing more difficult. It requires an additional step of ligating sticky ends/linker DNA to the restriction fragments for hydrogen bonds to form

Additional point to credit for H2 students:

15. Generate DNA fragments from genomic DNA when preparing genomic DNA library (OWTTE)
16. AVP

Modified from VJC/Prelim09/P3/Q4a

Examiner's Report

- Candidates should distinguish clearly the natural uses and applied uses of restriction enzymes.
- Candidates should analyse the question carefully as the question asked about the role of restriction enzymes in genetic engineering, NOT the entire process of genetic engineering.
- The restriction enzyme cuts at the restriction sites that flank both ends of the genes (or else the gene will be disrupted) to isolate the gene.
- Candidates should write cut the gene of interest out from the DNA, instead of cut the gene of interest (or else the gene will be disrupted).
- Candidates should note that only endonucleases hydrolyses the internal phosphodiester bonds between two specific adjacent nucleotides, while exonuclease hydrolyses the phosphodiester bonds between two specific adjacent nucleotides from the ends.

[1]

OR

5 (a) Describe the factors affecting the rate of photosynthesis. [8]

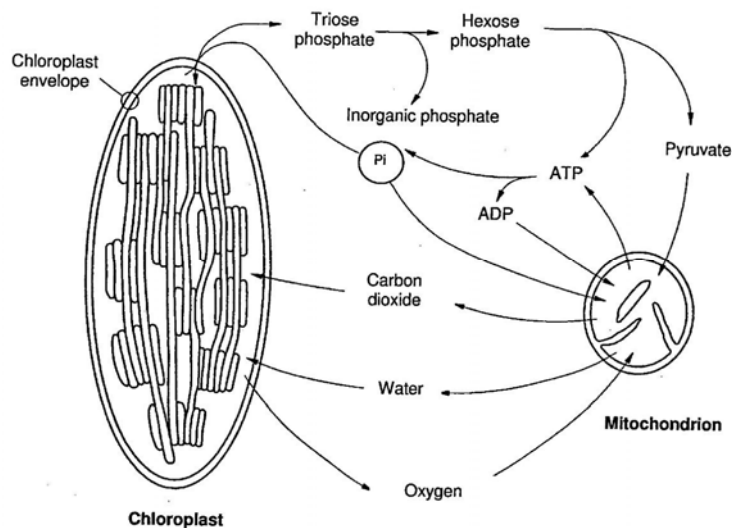
1. Effects of light intensity on:
 - a. excitation of electrons.
 - b. photolysis of water,
 - c. chemiosmosis,
 - d. stomata opening
2. Light quality (λ of light)
 - a. red or blue light preferred over green light
3. Effects of CO₂ concentration
 - a. rate of photosynthesis increases as the concentration of carbon dioxide increases.
4. Effects of temperature
 - a. Ref to enzymatic reactions in Calvin cycle.
5. Effects of O₂ concentration
 - a. As the concentration of oxygen increases, the rate of photosynthesis decreases.
 - b. whereby O₂ competes with CO₂ for the active site of Rubisco.

(b) Distinguish between the structures of the polysaccharides found in plant cells. [5]

Ref to:

1. Monomer
2. Types of bonds
3. Formation of chain
4. Structure of polysaccharide
5. Projection of hydroxyl groups on chains
6. Cross-linkage between chains
7. AVP

(c) Explain how the double membrane organelles in a plant cell synergize to ensure the cell's survival. [7]



Ref to

1. The nucleus contain genes that code for proteins required for mitochondria, chloroplast, and ribosomal proteins and genes that code for rRNA required for the assembly of ribosome.
2. The mitochondria
 - a. synthesize ATP during aerobic respiration. To supply energy for metabolic processes.
 - b. CO_2 released during aerobic respiration used during carbon fixation to synthesize glyceraldehyde-3-phosphate/ glucose in the chloroplast.
 - c. Water released during aerobic respiration can be used during photolysis of water in light reaction
3. The chloroplasts
 - a. synthesize organic compounds for aerobic respiration in the mitochondria.
 - b. O_2 released can be used in oxidative phosphorylation during aerobic respiration in the mitochondria.

[Total: 20]

2015/MCT/H1/P2/Q5c

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Modified from VJC/Prelim09/P3/Q4a

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- Candidates should write **cut the gene of interest out from the DNA**, instead of cut the gene of interest (or else the gene will be disrupted).
- Candidates should note that only **endonucleases** hydrolyses the **internal** phosphodiester bonds between two specific adjacent nucleotides, while exonuclease hydrolyses the phosphodiester bonds between two specific adjacent nucleotides **from the ends**.

Candidates should NOT confuse phages and bacteria, ie. **restriction enzymes should be found in bacteria to protect the bacteria from invading phages** (NOT protect the phage DNA from bacteria).