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

CANDIDATE NAME										
CENTRE NUMBER	S					INDEX NUMBER				
CLASS	C	G			/	1	6			

H1 BIOLOGY

Paper 1 Multiple Choice

8875/01

Monday 18 September 2017
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and index number on the Answer Sheet in the spaces provided unless this has been done for you.

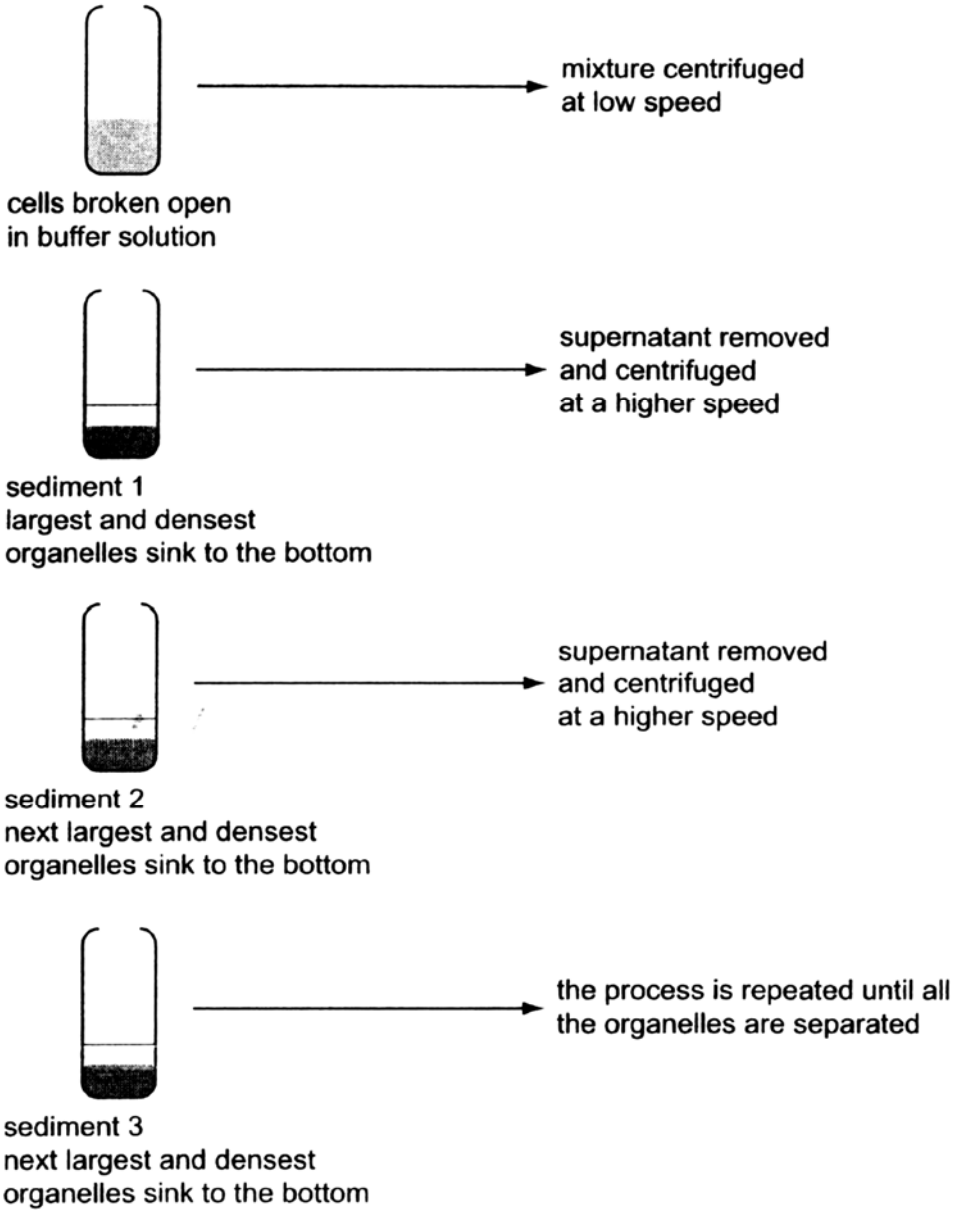
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the one you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

Read the instructions on the Multiple Choice Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **16** printed pages.

1 Fractionation is used to separate plant cell components of a leaf extract according to their size and density. The diagram shows the main steps in fractionation.



DCPIP and buffer solution were added to each sediment and the mixtures were left in the light for fifteen minutes. When DCPIP is reduced, it will turn from blue to colourless.

Which sediment(s) will cause DCPIP to be colourless?

A Sediment 2 only
B Sediment 3 only
C Sediments 1 and 2
D Sediments 2 and 3

2 The diagram shows five different structures that can be observed in cells.

1 2 3 4 5

Which structures would be present in large quantities in a cell that is actively synthesising the following molecules?

	Extracellular glycolipids	Proteins
A	1, 4, 5	3, 4, 5
B	1, 3, 4, 5	1, 2, 4, 5
C	2, 3, 4, 5	1, 2, 4, 5
D	2, 3, 4, 5	1, 3, 4, 5

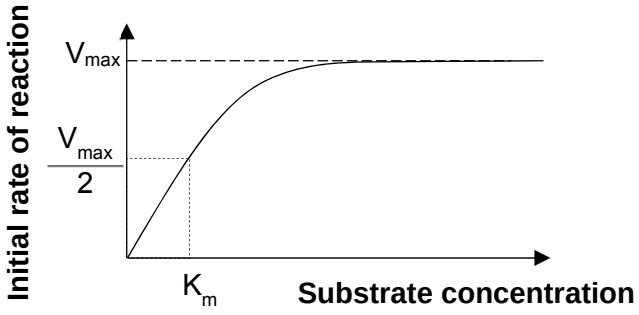
3 Keratin is a fibrous protein in skin, hair and nails. The features of one form of keratin are listed.

1 The peptide chain has mainly small amino acid residues.
2 Each peptide chain forms an α-helix.
3 Two helices coil together.
4 Covalent bonds link adjacent helices.

Which features are the same in collagen molecule?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

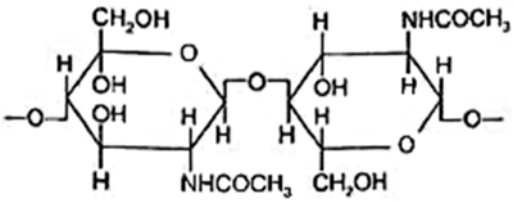
4 The value K_m is the substrate concentration at which the rate of an enzyme-catalysed reaction is half its maximum rate, $\frac{Vmax}{2}$. The K_m was measured in the presence of a competitive inhibitor and a non-competitive inhibitor.



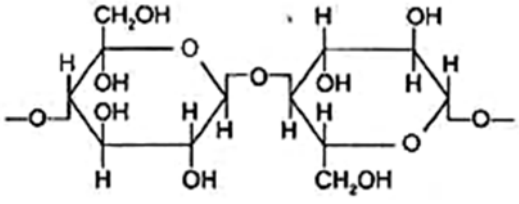
How will the value of K_m be affected in the presence of inhibitors?

	value of K_m in presence of	
	competitive inhibitor	non-competitive inhibitor
A	less	less
B	less	more
C	more	less
D	the same	more

5 The diagrams show short sections of some common polysaccharides and modified polysaccharides.



1



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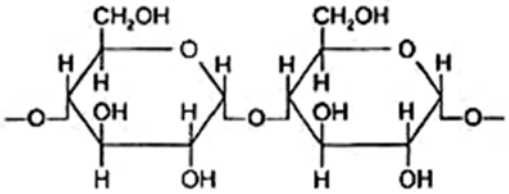

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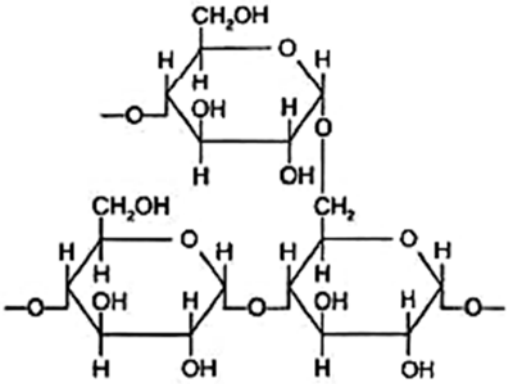

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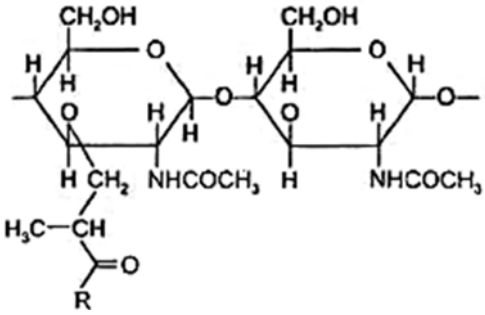


5

The polysaccharides can be described as below.

- polysaccharide F is composed of β-glucose monomers with 1,4 glycosidic bonds
- polysaccharide G is composed of α-glucose monomers with 1,4 and 1,6 glycosidic bonds
- polysaccharide H is composed of N-acetylglucosamine and N-acetylmuramic acid monomers with β-1,4 glycosidic bonds
- polysaccharide J is composed of α-glucose monomers with 1,4 glycosidic bonds
- polysaccharide K is composed of N-acetylglucosamine monomers with β-1,4 glycosidic bonds

Which shows the correct pairings of polysaccharide descriptions and diagrams?

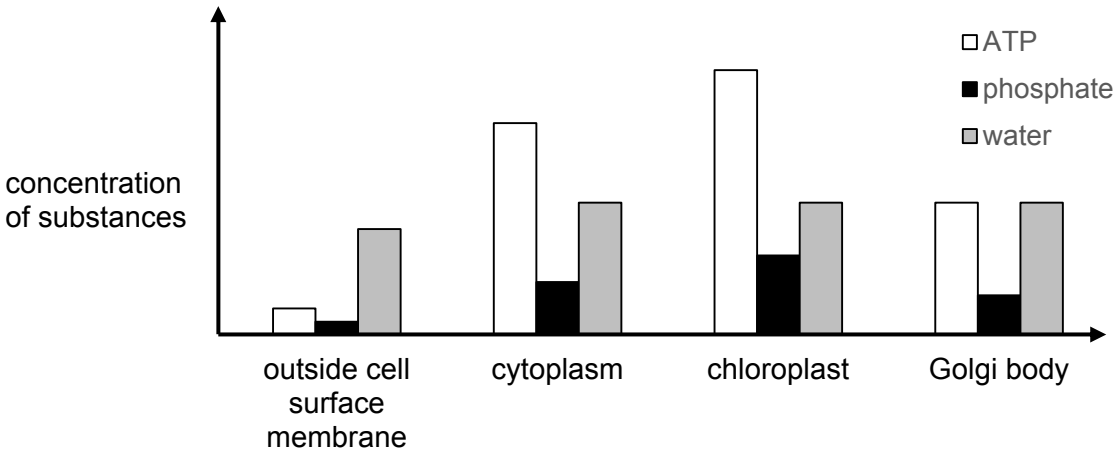
	polysaccharide F	polysaccharide G	polysaccharide H	polysaccharide J	polysaccharide K
A	2	4	5	3	1
B	2	5	4	1	3
C	3	4	1	2	5
D	3	5	4	1	2

6 Which of the following statement about membranes is correct?

1 All intracellular membranes in a eukaryotic cell have the same type of lipids and proteins.
2 The outer and inner membranes of mitochondria have the same type of transport proteins.
3 Carbohydrates form part of glycoproteins or glycolipids in the membranes.
4 All plant cell membranes have cholesterol.

A 3 only
B 1 and 4
C 2 and 3
D 1, 3 and 4

7 The chart shows the concentration of some substances outside the cell surface membrane, in the cytoplasm, in the chloroplast and in the Golgi body of a plant cell.

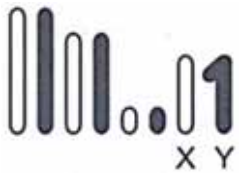


Which statement about the direction of movement of these substances and the process by which they are moving is correct?

A ATP is leaving the chloroplast by facilitated diffusion, water is leaving the plant cell by osmosis.
B Phosphate and ATP are entering the chloroplast and Golgi body by active transport.
C Phosphate and ATP are leaving the Golgi body by facilitated diffusion, water is leaving the plant cell by osmosis.
D Phosphate is entering the chloroplast by facilitated diffusion, water is entering the chloroplast by osmosis.

8 No crossing over occurs during meiosis in male fruit flies of the species *Drosophila melanogaster.*

The diagram shows the four pairs of homologous chromosomes present in a testis cell of a male fly.



Which set of chromosomes in a gamete nucleus shows the genetic variation resulting from independent assortment?

A

B

C

D

9 What is the role of stem cells with regards to the function of adult tissues and organs?

A Stem cells are fully differentiated cells that reside under the surface of epithelial tissue, in position to take over the function of the tissue when the overlying cells become damaged or worn out.

B Stem cells are totipotent cells that divide asymmetrically, giving rise to one daughter cell that remains a stem cell and one daughter cell that will differentiate to replace damaged and worn out cells in the adult tissue or organ.

C Stem cells are embryonic cells that persist in the adult, and can give rise to all of the cell types in the body.

D Stem cells are cells that have yet to express the genes and produce proteins characteristic of their differentiated state, but do so when needed for repair of tissues and organs.

10 A gene coding for an ion channel consists of 249 999 base pairs, which have 26 introns and 27 exons. During mRNA processing, a final transcript of 3570 bases is left.

How many additional amino acids would have been needed had the gene not contained introns?

A 82 143

B 83 324

C 83 333

D 83 342

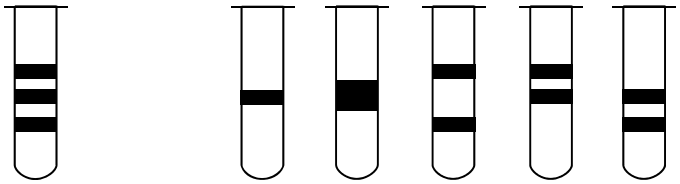
11 Antibiotics are used to kill pathogens that infect people, without causing damage to human cells.

Different antibiotics work in different ways.
- Erythromycin binds to bacterial ribosomes.
- Nystatin binds to ergosterol which replaces cholesterol in pathogenic fungi.
- Rifampicin binds to bacterial RNA polymerase.
- Ciprofloxacin binds to DNA topoisomerase (enzyme that removes supercoiling of DNA).

Which antibiotic directly inhibits the following process in pathogens?

	Membrane formation	DNA replication	Transcription	Translation
A	rifampicin	ciprofloxacin	erythromycin	nystatin
B	rifampicin	nystatin	erythromycin	ciprofloxacin
C	nystatin	ciprofloxacin	rifampicin	erythromycin
D	nystatin	rifampicin	ciprofloxacin	erythromycin

12 Cells of the bacterium *E. coli* were grown for many generations on a medium containing only the heavy isotope of nitrogen ^{15}N. The cells were then transferred to a medium containing only ^{14}N and grown for two generations. Samples of the bacteria were then removed from the culture. The DNA from each sample was extracted and centrifuged at very high speeds in a solution of caesium chloride. The diagram below illustrates the distribution of DNA in various centrifuge tubes, 1, 2, 3, 4 and 5.



Which of the centrifuge tube above would support the hypothesis of conservative and semi-conservative DNA replication?

	conservative replication	semi-conservative replication
A	4	2
B	2	3
C	3	4
D	5	1

13 Which of the following statement is correct?

1 Each nucleosome consists of DNA wound twice around a histone octamer, a protein core made up of 4 different types of histone proteins.
2 Negatively charged histones bind tightly to positively charged DNA via ionic attractions.
3 The 10nm fibre coils to form a 30nm chromatin fibre or solenoid.
4 The 8 nucleosomes assemble to form looped domains, which are attached to chromosome scaffolds.
5 The looped domains coil further to form highly condensed chromosomes during prophase.

A 1, 2, 3
B 1, 3, 5
C 1, 3, 4, 5
D 2, 3, 4, 5

14 In most organisms, six different triplets of the DNA strand that is complementary to mRNA code for the amino acid serine: AGA, AGG, AGT, AGC, TCA and TCG.

In the yeast *Candida albicans*, a seventh DNA triplet, GAC, also codes for serine. In most organisms, this triplet codes for leucine.

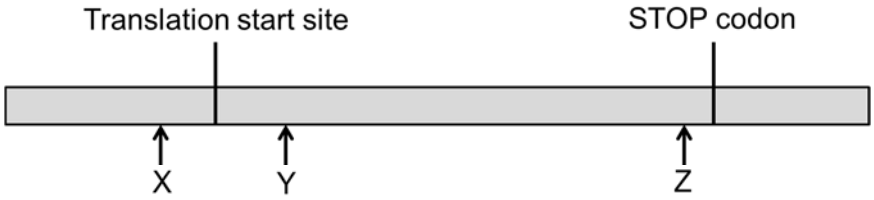
The diagram shows part of an mRNA molecule from *C. albicans*.

	AGU	UCG	CGG	UCA	AGC	ACC	UGG
codon number	11	12	13	14	15	16	17

Which mutation of the DNA that is complementary to this mRNA could result in *C. albicans* producing a polypeptide with a continuous sequence of five serines in it?

A substituting a purine with a pyrimidine in the DNA coding for codon 13
B substituting a purine with a pyrimidine in the DNA coding for codon 16
C substituting a pyrimidine with a purine in the DNA coding for codon 13
D substituting a pyrimidine with a purine in the DNA coding for codon 16

15 During the process of transcription, errors sometimes occur such that certain nucleotides are repeated. The diagram shows a strand of mRNA produced from a particular gene.



Which of the following event will most likely lead to the synthesis of a non-functional protein?

A One base pair is inserted at **X**.
B Three base pairs are inserted at **X**.
C One base pair is inserted at **Y**.
D Three base pairs are inserted at **Z**.

16 The speech defect known as stuttering may involve two genes, **G** and **N**. Most people are homozygous for the alleles **g** and **n** and are not stutterers.

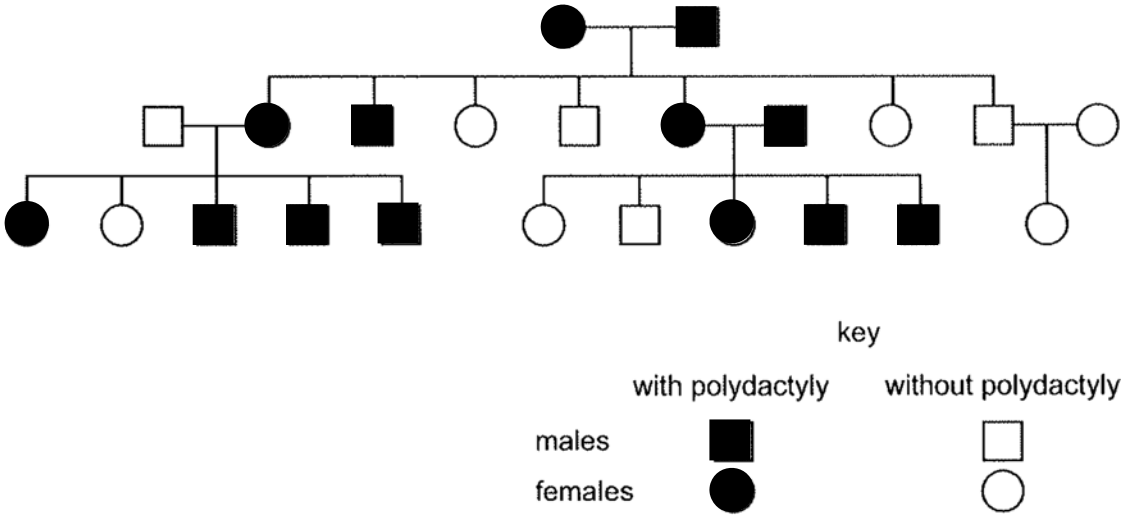
However, recent research has shown that the presence of either of the mutant alleles **G** or **N** can cause stuttering in heterozygotes.

Using this information, which proportion of the children of a couple, the father with genotype **Ggnn** and the mother **ggNn**, are likely to be stutterers?

A 3/16
B 8/16
C 9/16
D 12/16

17 Polydactyly is a genetic condition, controlled by a single gene, in which people are born with extra fingers and toes.

The diagram shows the pedigree of a family.



What is true about the inheritance of polydactyly?

	The allele coding for polydactyly is dominant	The allele coding for polydactyly is autosomal	Offspring of parents with polydactyly will all inherit the allele	More males than females will inherit the polydactyly allele
A	True	True	False	False
B	True	False	False	True
C	False	False	False	True
D	False	False	True	True

18 Which statement concerning chrysanthemum plants, of the genus *Dendranthema,* is a valid example of how the environment may affect the phenotype?

A Anthocyanins and anthoxanthins are vacuolar pigments, whereas xanthophylls and carotenes are pigments found in membrane-bound organelles known as plastids. These, together with molecules known as co-pigments, are responsible for the variation observed in petal colour in *Dendranthema.*

B Identical genetic crosses performed between varieties of *Dendrathema* result in a greater proportion of offspring plants with plastids exhibiting a yellow colour when grown in a field and a greater proportion of offspring plants with colourless plastids when grown in a glasshouse.

C The seeds of a cross between *Dendranthema weyrichii* and *Dendranthema grandiflora* produce plants that are far more frost-tolerant and exhibit an extended flowering season compared with both parent plants.

D The seeds of a cross between *Dendranthema weyrichii* (height varying between 12.5–15.0 cm) and *Dendranthema grandiflora* (height varying between 8.0–25.0 cm) produce plants, when grown in natural day length, of a height varying between 55.0–71.0 cm.

19 The pigment haemoglobin found in red blood cells of mammals and birds combines readily with oxygen.

DNA analysis has revealed that a form of haemoglobin is found in a wide range of unrelated phylogenetic groups including bacteria, annelids, anthropods and leguminous plants.

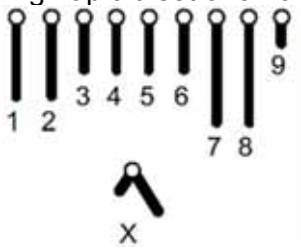
Which evolutionary processes could account for the distribution of haemoglobin in such a wide variety of organisms?

	adaptive radiation	conservation of genes	natural selection
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✓

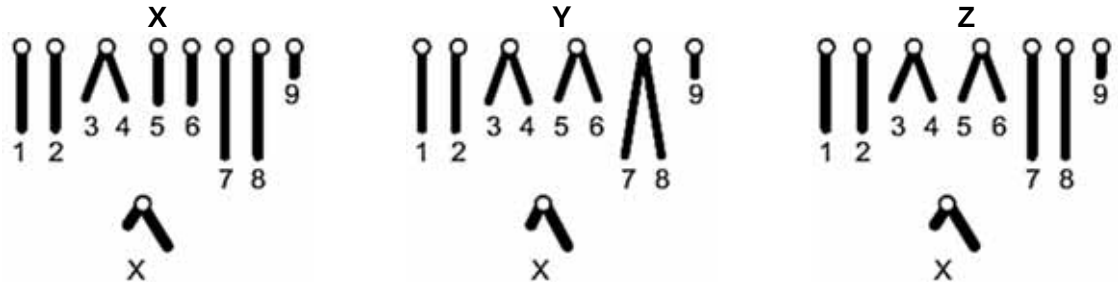
key
✓ true
✗ false

20 In some Australian insects, new species have arisen through changes that occurred to chromosomes in an ancestral species. Such changes may involve the joining of chromosomes, the loss of whole or parts of chromosomes, and rearrangement of the genetic material within chromosomes.

One ancestral species has the following haploid set of chromosomes.



Three new species have the haploid sets of chromosomes shown below.



What is the most likely order in which these species appear?

A ancestral species, species **Z**, species **X**, species **Y**.
B ancestral species, species **X**, species **Y**, species **Z**.
C ancestral species, species **Y**, species **X**, species **Z**.
D ancestral species, species **X**, species **Z**, species **Y**.

21 Bacteria in the genus *Wolbachia* infect many butterfly species. They are passed from one generation to the next in eggs, but not in sperm, and they selectively kill developing male embryos.

In Samoa in the 1960s, the proportion of male blue moon butterflies fell to less that 1% of the population. However, by 2006, the proportion of males was almost 50% of the population.

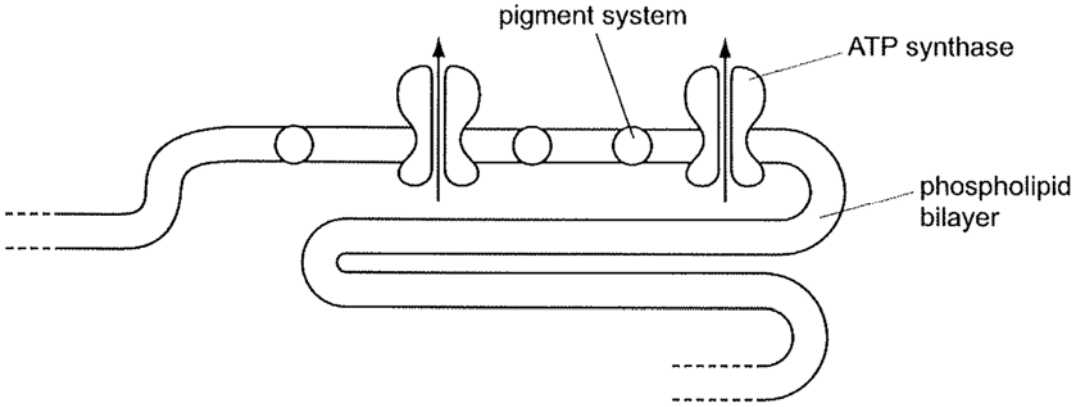
Resistance to *Wolbachia* is the result of the dominant allele of a suppressor gene.

Which statements correctly describe the evolution of resistance to *Wolbachia* in the blue moon butterfly population?

1 *Wolbachia* acts as a selective agent.
2 The selective killing of male embryos is an example of artificial selection.
3 When infected with *Wolbachia,* male embryos that are homozygous for the recessive allele of the suppressor gene die.
4 All male embryos that carry the dominant allele of the suppressor gene pass that allele to their offspring.
5 The frequency of the dominant allele of the suppressor gene rises in the butterfly population.

A 1 and 4
B 1, 3 and 5
C 2 and 3
D 2, 4 and 5

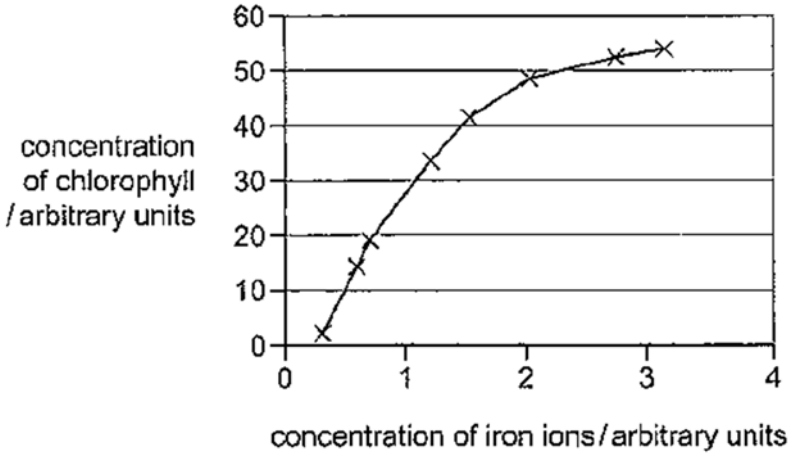
22 The diagram shows a small part of a thylakoid membrane. The arrows represent the movement of a particular reaction product through the ATP synthase.



From which chemical was this product derived from?

A NADH **B** NADPH **C** Oxygen **D** Water

23 The concentration of chlorophyll in the leaves of beetroot plants grown in increasing concentrations of iron ions was measured. The concentration of the breakdown products of chlorophyll was not determined. The graph shows the results.



What conclusions can be drawn from the results?

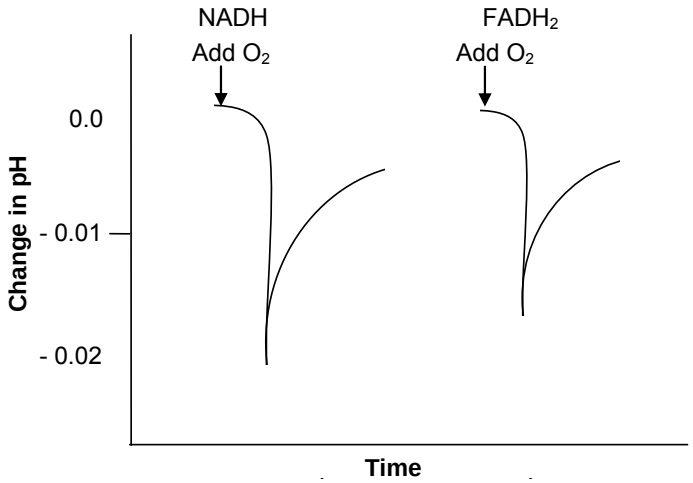
1 Concentration of chlorophyll was directly proportional to the concentration of iron ions.
2 Concentration of iron ions was a limiting factor for the production of chlorophyll.
3 Plants given a higher concentration of iron ions synthesised more chlorophyll.
4 Plants given a higher concentration of iron ions increased their rate of photosynthesis.

A 2 and 3
B 3 and 4
C 1, 2 and 3
D 1, 2 and 4

24 Which set of reactions releases the smallest number of ATP molecules by substrate level phosphorylation?

A conversion of glucose to ethanol and carbon dioxide
B conversion of glucose to lactic acid
C glycolysis of glucose
D one turn of the Krebs cycle

25 Isolated mitochondria were incubated with NADH in one experiment and an equal amount of $FADH_2$ in another set up. The mitochondria were initially deprived of oxygen. A known quantity of oxygen was then added and the pH of the intermembrane space was monitored. The result is shown in the graph.

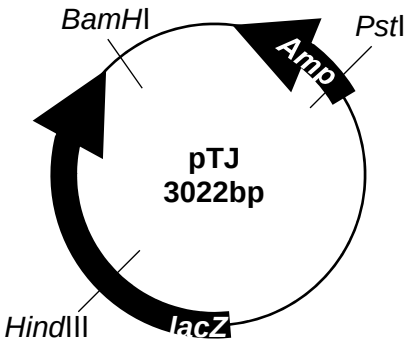


Which of the following can be concluded based on the results?

1 Upon the addition of oxygen, glycolysis and subsequently link reaction, Krebs cycle and oxidative phosphorylation occurred.
2 Electron transfer was initiated by the addition of oxygen.
3 The pH drop was greater with NADH than with $FADH_2$, which is consistent with the greater ATP yield that accompanies the oxidation of NADH.
4 The rapid decline in pH indicates that protons were pumped into the intermembrane space when oxygen was available.

A 1 only
B 2 and 4 only
C 2, 3 and 4 only
D All of the above

26 The restriction sites and selectable markers on the vector pTJ are shown below.



If the gene for C protein were to be inserted into *lacZ* site, what should be added to the agar plate in order to screen for recombinant clones and how would the recombinant clones appear?

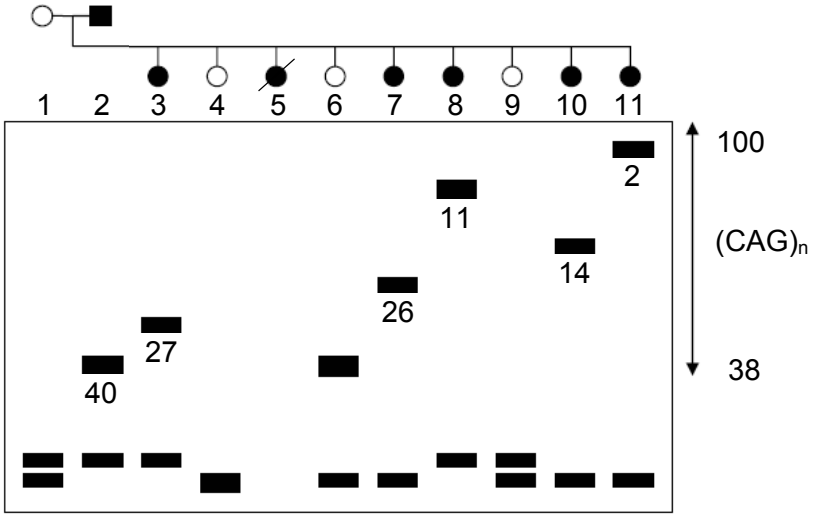
	Chemicals to be added		Colour of colonies
A	ampicillin	X-gal	Blue
B	β-galactosidase	X-gal	Blue
C	ampicillin	X-gal	White
D	β-galactosidase	lactose	White

27 Which of the following is correct?

	Polymerase Chain Reaction	Translation
A	Occurs in the nucleus	Occurs in the cytoplasm
B	Requires ribonucleic acids	Does not require deoxyribonucleic acids
C	Synthesizes selected section of the DNA	Synthesizes selected section of the mature mRNA
D	Uses information on the template between the primers	Uses information on the template between the start and stop codons

28 The diagram below shows the results of electrophoresis of PCR fragments. Individuals with Huntington's disease have nucleotide sequence CAG that repeats from 36 to more than 120 times.

The male parent (individual 2) suffers from Huntington's disease when he was 40 years old. Six of his children (individuals 3, 5, 7, 8, 10, 11) suffer from Huntington's disease, and the age at which the symptoms first began is shown by the number below the band containing the PCR fragments.



What conclusion can be drawn from the data above?

A Individuals 4, 6, and 9 have not inherited the allele that causes Huntington's disease.

B Individuals 4, 6, and 9 will still develop Huntington's disease at some point in their lives, since the disease is inherited as a dominant trait.

C Individuals 4 and 9 do not have the trait, and will not get Huntington's disease, but individual 6 is likely to have the disease when she reaches her father's age of 40.

D Two of the three will develop the disease, since it is inherited as a dominant trait, but the data does not allow us to predict which two.

29 What is a concern over the creation of genetically modified farmed animals?

1 Some genetically modified food products may cause allergies.

2 Gene transfer between genetically modified farmed animals and those in the wild may alter the gene pool of the species in the wild.

3 Overproduction of certain gene products may cause undue stress to the genetically modified farmed animals.

4 Some genetically modified food products may not be acceptable to certain groups of people.

A 1 and 4

B 2 and 3

C 1, 3 and 4

D All of the above

30 The Human Genome Project (HGP) has brought about great advancements in health and medicine.

Which of the following statements about HGP is correct?

	intended application	ethical concerns
A	developing diagnostic test to identify the gender of a foetus by detecting the presence of the foetal Y chromosome	designing of new antibody-based medicines which target proteins coded for by oncogenes
B	using a suspect's genetic pre-disposition to violent behaviour in criminal trials	screening the genetic make-up of an individual for genetic predisposition to cancer to determine if the individual is suitable to work in a nuclear power plant
C	comparing homologous genes of different human populations to trace lineages and migration patterns	comparing homologous genes to determine evolutionary relationships between organisms
D	prescribing suitable drugs to minimise adverse side effects due to the individual's inability to metabolize the medicine	publishing genetic information of specific individuals in a database readily accessible by the public

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

CANDIDATE NAME										
CENTRE NUMBER	S					INDEX NUMBER				
CLASS	C	G			/	1	6			

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.

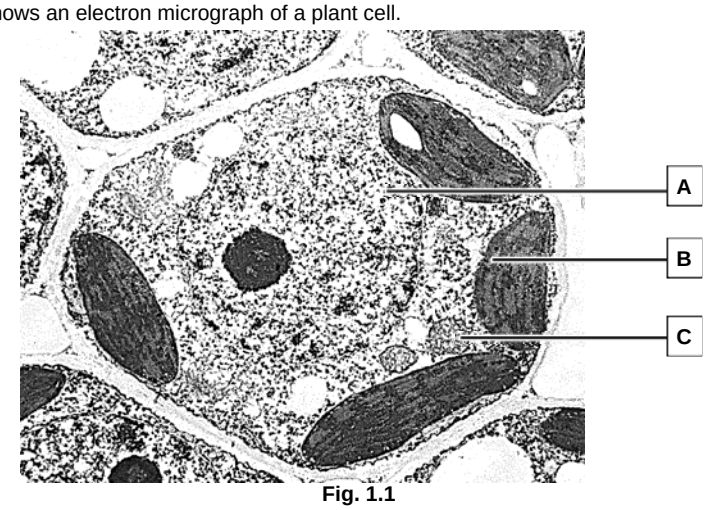


Fig. 1.1

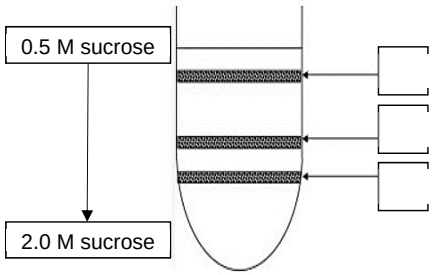
(a) Identify organelles **B** and **C**.

Organelle **B**: _____ [1]

Organelle **C**: _____ [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]

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.

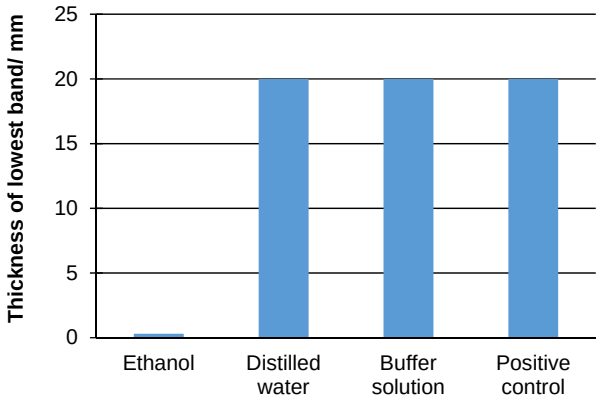


Fig. 1.2

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

[3]

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

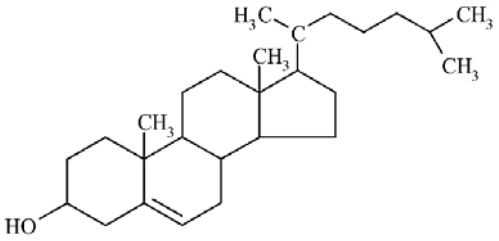


Fig. 1.3

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

_____

_____

_____

_____ [2]

[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]

(b) Outline the process of transcription.

[3]

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.

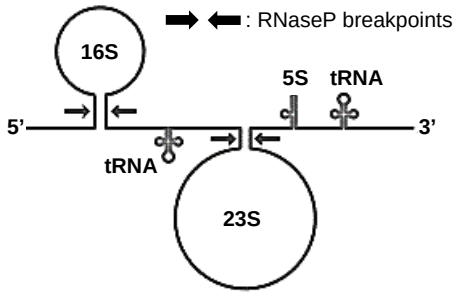


Fig. 2.1

(c) State where rRNA genes are found.

[1]

(d) Compare the process of RNA trimming and post-transcriptional modification for mRNA.

[2]

(e) Relate how the single-stranded structure of rRNA and tRNA facilitates their roles.

[4]

[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.

```
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151 ATTGCTATAC CATGTCTCCC AAAACCCAAT TTTGTCATAT TATGTACCCA
201 AGACTCTGGT ACTATGTTTC CTGGGGCATA ATTTTGGCAC AATCTCTCTC
251 CCTCGCCCTG TTCCCTGCAG GAAAGTATGG TGCCTTGGAT GCGGGGGCTC
301 TGCTGGCGCT GCTGCCACTA ACGGAAGACC AGGAGAGCAA GGTGCGCCTC
351 TATGCCCTGA AGGCTCTGAC TGTCTTGGCT GTATTCGTAC 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**: _____

Primer **Y**: _____ [2]

Fig. 3.1 shows the phylogenetic relationships among Anole lizards. The results from gel electrophoresis of amplified *rtdr1y* and *kank1* sequences are also shown.

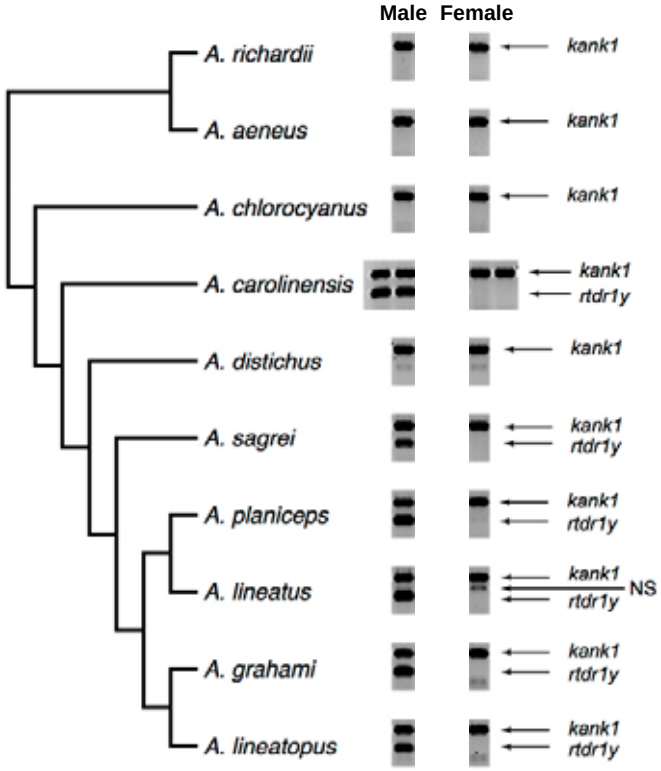


Fig. 3.1

(b) Explain which type of chromosome *rtdr1y* sequence is found on.

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

[2]

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]

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

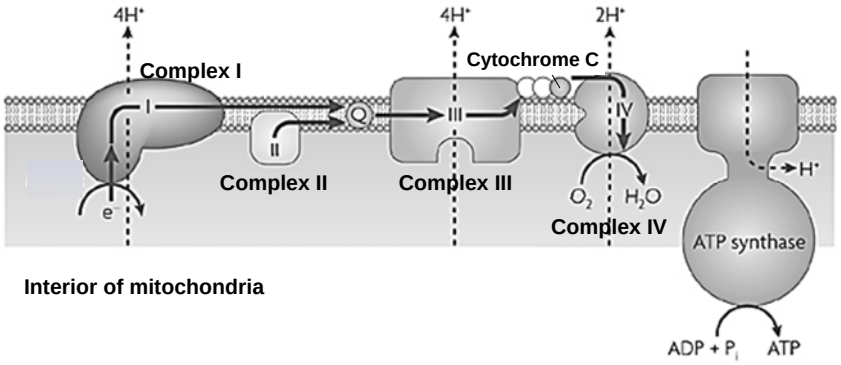


Fig. 3.2

(d) Explain the significance of cytochrome c in the process shown.

[3]

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.

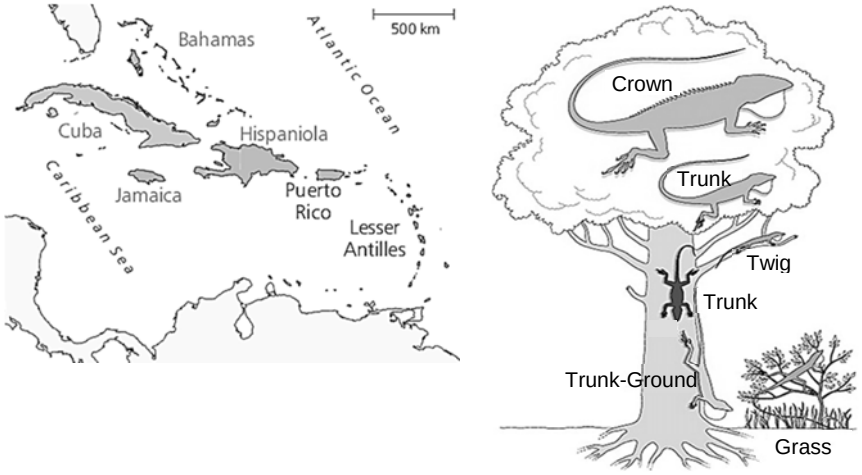


Fig. 3.3

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

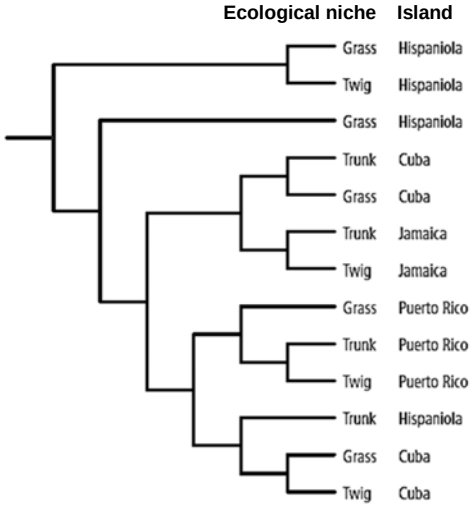


Fig. 3.4

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

[5]

[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]

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

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

[Total: 20]

OR

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

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

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

[Total: 20]

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

CANDIDATE NAME										
CENTRE NUMBER	S					INDEX NUMBER				
CLASS	C	G			/	1	6			

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.

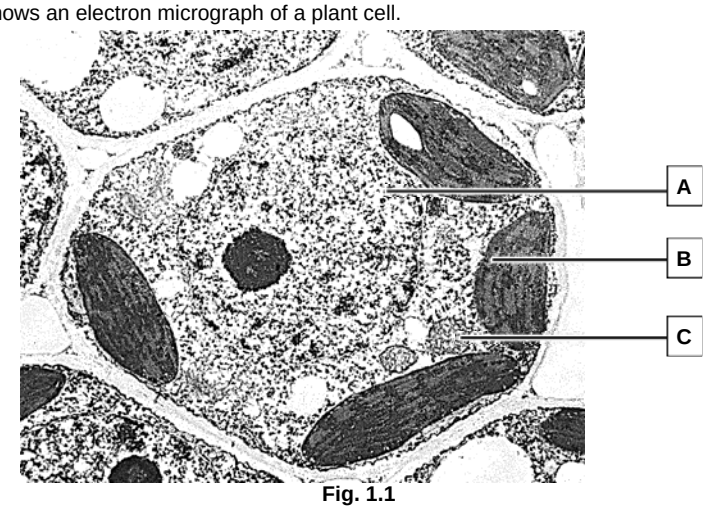


Fig. 1.1

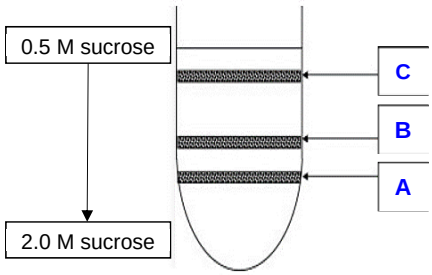
(a) Identify organelles **B** and **C**.

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.

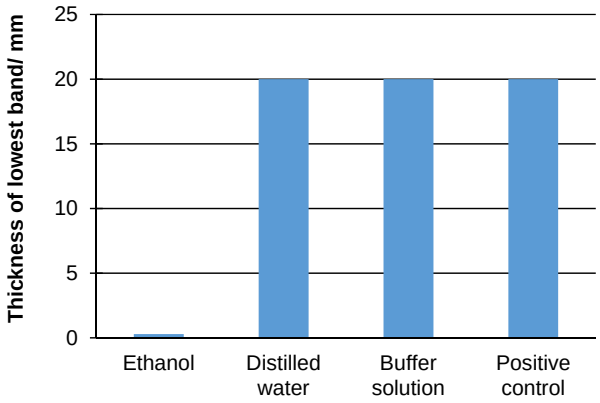


Fig. 1.2

(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.

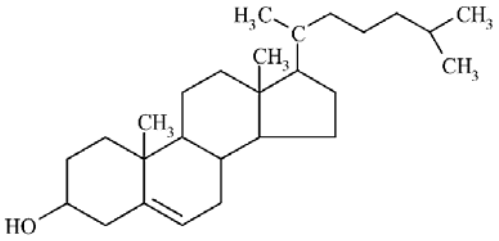


Fig. 1.3

(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.

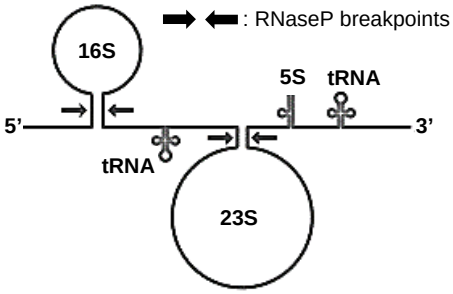


Fig. 2.1

(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]

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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' TGATTTCCGTGG 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 *rtdr1y* and *kank1* sequences are also shown.

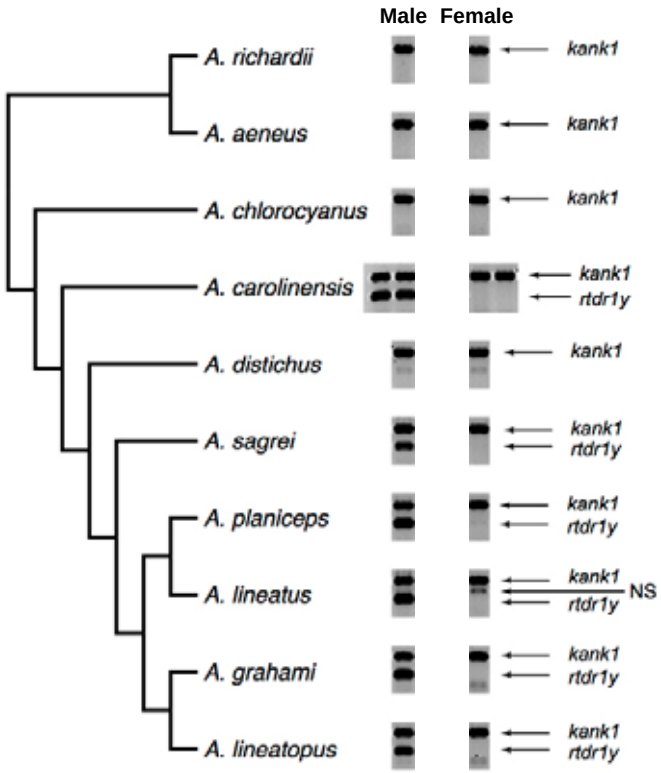


Fig. 3.1

(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.

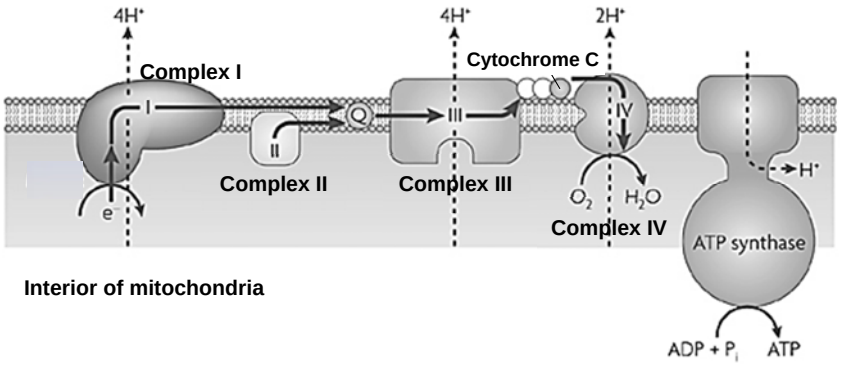


Fig. 3.2

(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.

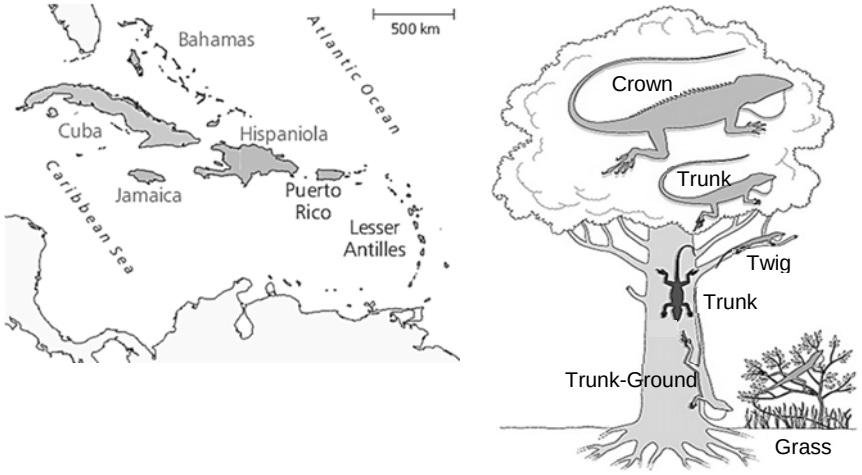


Fig. 3.3

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

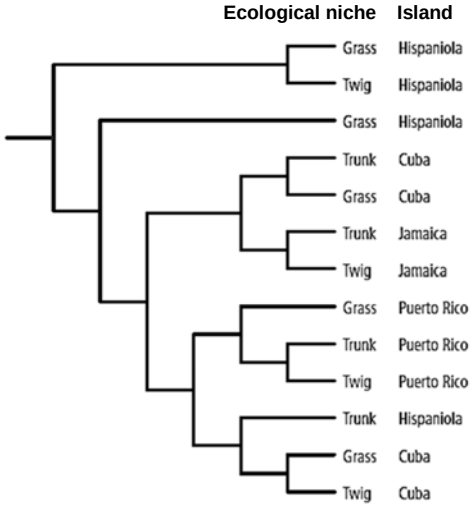


Fig. 3.4

(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 ($-CH_3$) 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 CO_2 concentration**
    a. **rate of photosynthesis increases as the concentration of carbon dioxide increases.**

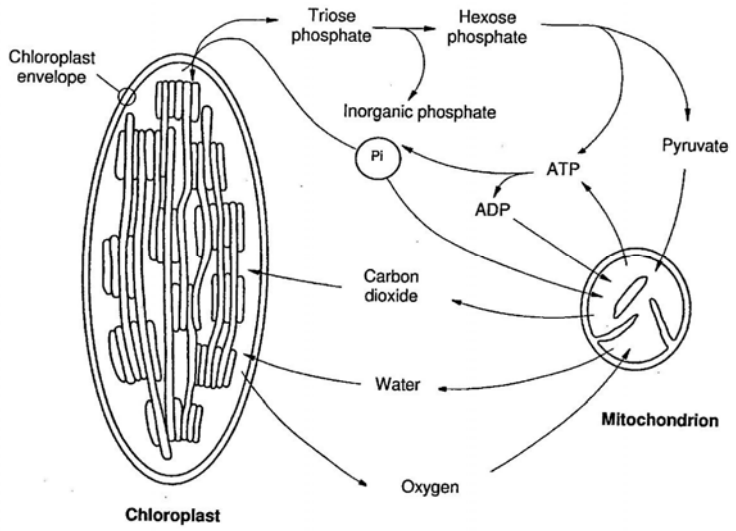
4. **Effects of temperature**
    a. **Ref to enzymatic reactions in Calvin cycle.**
5. **Effects of O_2 concentration**
    a. **As the concentration of oxygen increases, the rate of photosynthesis decreases.**
    b. **whereby O_2 competes with CO_2 for the active site of Rubisco.**

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

Ref to:

1. **Monomer**
2. **Types of bonds**
3. **Formation of chian**
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]

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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 (-CH_3) 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.**

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).

Prep list for Prelim Practical 2017

For Question 1

Per student

Item	Quantity	Remarks
0.5% Starch suspension*	15 cm^3	Starch powder mixed with cold water, unboiled.
1% Amylase + 1% albumin	15 cm^3	Prepare separately as 1% solutions then mix together and labelled as "Solution X".
Iodine*	1:10 dilution, 10 ml	In amber dropping bottle
5ml syringes*	4	
Plastic droppers*	4	
test-tubes*	5	
Plastic vials*	4	
Black card*	1	10cm by 10cm
White tile	1	
Aqueous copper sulfate solution	1 dropping bottle	
Diluted sodium hydroxide	1 dropping bottle	
Microscope slides	3	
Ethanol (denatured) solution	1 dropping bottle	
500ml beaker	1	
Plastic 500ml beaker	1	
Bunsen burner	1	
Tripod stand & wire gauze	1 set	
Spotting tile	1	
test-tube rack	1	
Stop watch	1	
Label stickers	14	
Hand lens	1	
Paper towel	3	
Lighter	1	
Hot water at side bench	-	

* items to be changed per shift

For Question 2

Per student

Item	Quantity	Remarks
Microscope with ×10 eyepiece and ×40 objective lenses	1	
M16390/5 Slide **E**	1	Each slide contains 3 different samples (Mesophytic, hydrophytic, xerophytic leaf)