HWA CHONG INSTITUTION
2016 JC2 H1 BIOLOGY
PRELIMINARY EXAMINATION PAPER 1 & 2 MARK SCHEME

MULTIPLE CHOICE QUESTIONS

1	**B**	11	**B**	21	**B**
2	**B**	12	**A**	22	**D**
3	**D**	13	**D**	23	**A**
4	**D**	14	**A**	24	**A**
5	**C**	15	**A**	25	**D**
6	**D**	16	**A**	26	**D**
7	**C**	17	**D**	27	**B**
8	**D**	18	**C**	28	**B**
9	**A**	19	**C**	29	**A**
10	**B**	20	**C**	30	**C**

STRUCTURED QUESTIONS

QUESTION 1

(a) Explain the role of helicase in DNA replication. [2]

1. separates/unwinds / unzips strands / helix / breaks H-bonds
2. so nucleotides can attach / parental DNA strands can act as templates

(b) Explain how cytarabine prevents DNA replication. [2]

1. similar structure to cytosine added instead of cytosine
2. prevents complementary base pairing / prevents strand elongation

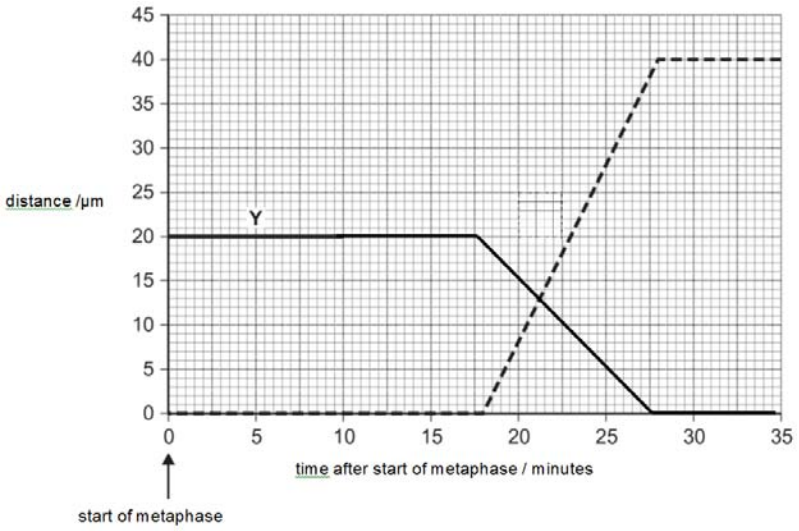
With reference to Fig. 1.2,

(c) **(i)** state the duration of metaphase in the cell. [1]

18min

(ii) complete line **Y** on the graph. [1]

horizontal until 18 minutes, then decreases as straight line to 0 μm at 28 minutes



(iii) account for your answer in **(c)(ii)**. [3]

1. chromosomes / pairs of sister chromatids align singly at the metaphase plate during metaphase of mitosis
2. hence, from 0 minute to 18 minutes, the distance of each chromatid and the pole to which it is moving was constant at 20 μm

3a. sister chromatids separate at the centromere to become daughter chromosomes

3b. and migrate towards the opposite poles in anaphase

4. hence, the distance of each chromatid / daughter chromosome and the pole decreased from 20 μm to 0 μm from 18 minutes to 28 minutes at the end of anaphase
5. each chromatid / daughter chromosome did not move / remain at the pole in telophase
6. hence, the distance of each chromatid / daughter chromosome was constant at 0 μm

[Total: 9]

QUESTION 2

(a) **(i)** State precisely where RuBP and GP are located in the chloroplast. [1]

Stroma

(ii) Explain why the concentration of RuBP changed between 200 and 275 seconds. [2]

1. during this period, CO_2 concentration is lower
2. since less CO_2 fixed by RuBP / CO_2 combining with RuBP / RuBP converted to GP
3. moreover, RuBP is regenerated from triose phosphate

(b) Suggest how the decrease in the concentration of GP leads to a decrease in harvest for commercial suppliers of *Chlorella*. [2]

1. a decrease in the concentration of GP will lead to less triose phosphate / glyceraldehyde-3-phosphate being produced
2. so less conversion of triose phosphate to carbohydrates / lipids / amino acids / proteins

(c) In the light dependent stage, illumination of chloroplasts is important for maintaining the high pH in the stroma.

Explain how the illumination of chloroplasts maintains the high pH in the stroma. [3]

1. illumination of chloroplasts excite and displace electrons from special chlorophyll a / photosystem / ref. to photoactivation of chlorophyll
2. electron is then passed down the electron transport chain
3. free energy is used to pump protons into thylakoid lumen from the stroma
4. protons also released from the photolysis of water
5. this leads to lower concentration of protons in stroma maintains pH

[Total: 8]

QUESTION 3

(a) (i) Suggest and explain **one** such adaptation in the woolly mammoth. [2]

1. having thick fur / small ears
2. to reduce heat loss

(ii) Explain how natural selection may have brought about the evolution of the woolly mammoth from the steppe mammoth. [4]

1. presence of much cooler conditions in the environment which serves as selection pressure
2. mammoths with favourable traits are at a selective advantage
3. differential survival and reproductive abilities
4. those selected for can pass down favourable allele to offspring
5. over time, the change in allelic frequency in the population

(b) Explain the likely effect of these differences on a molecule of mammoth haemoglobin. [3]

1. difference in primary sequence of amino acids of the polypeptide results in presence of different side chains
2. this changes the bonds formed between the R groups, resulting in a change in the 3D conformation / tertiary structure of each haemoglobin chain
3. as 2 α and 2 β chains are required to form the quaternary structure of haemoglobin / ref. to effect of quaternary structure
4. greater effect on β chain
5. there will be a change in function of each haemoglobin molecule

[Total: 9]

QUESTION 4

(a) Using the symbols **A** and **a** for colour of grain and **B** and **b** for texture of grain, draw a genetic diagram to explain these results. [4]

F1 phenotype purple and smooth x purple and smooth

F1 genotype AaBb x AaBb

Gametes (AB, Ab, aB, ab) x (AB, Ab, aB, ab)

Random fertilisation		male gametes			
		AB	Ab	aB	ab
female gametes	AB	AABB	AABb	AaBB	AaBb
	Ab	AABb	AAbb	AaBB	Aabb
	aB	AaBB	AaBb	aaBB	aaBb
	ab	AaBb	Aabb	aaBb	aabb

F2 genotypic ratio 9 A _ B _ : 3 A_ bb : 3 aa B_ : 1 aabb
F2 phenotypic ratio 9 purple & smooth : 3 purple & shrunken : 3 yellow & smooth : 1 yellow & shrunken

(b) Explain why yellow and shrunken grains breed true. [2]

1. the yellow shrunken grains are double homozygous recessive at the two gene loci
2. when it is self-fertilised, it will produce only double homozygous recessive offspring, which resemble the parental genotype

(c) Explain why it is possible for rice plants to express genes from a bacterium. [1]

1. all organisms share the same genetic code

(d) **(i)** Describe the role of the rice endosperm-specific promoter that was added to *psy* and *crt* 1 in **step 1**. [2]

1. role of promoter is to switch on genes
2. only in the rice endosperm and not expressed anywhere else would be a waste of energy
3. since it is the edible part of seed

(ii) Explain how a length of DNA can be inserted into a plasmid in **step 2**. [3]

1. use restriction enzyme to cut plasmid open
2. sticky ends anneal via complementary base pairing, A - T / C - G
3. role of DNA ligase, in joining sugar-phosphate backbone

(e) (i) Suggest **one** possible risk to the environment of growing a genetically engineered crop. [1]

1. gene transfer to other rice
2. contamination of other crop (e.g. ref to organic crop)
3. gene transfer to wild relative

(ii) Suggest **one** possible risk to human health of eating a genetically engineered crop. [1]

1. allergy
2. long term toxicity
3. antibiotic resistance of gut bacteria if antibiotic marker used

[Total: 14]

FREE RESPONSE QUESTIONS

QUESTION 5

(a) Describe how the molecular structure of cellulose is related to its support function. [6]

1. alternate inverted β-glucose units linked by β(1,4) glycosidic bonds allow cellulose to form long, unbranched and straight chains
2. few organisms have enzymes to hydrolyse β(1,4) glycosidic bonds, hence cellulose is stable
3. alternate inverted β-glucose units linked by β(1,4) glycosidic bonds allow cellulose to form long, unbranched and straight chains
4. allow formation of linear chains of polysaccharides that can be packed tightly
5. many chains run parallel to each other and their hydroxyl group (OH) project outwards from each chain
6. extensive hydrogen bonds form between parallel chains/ Extensive hydrogen bonds form between the protruding OH groups of neighbouring chains
7. allowing establishment of rigid cross-links between chains
8. cross-linked cellulose chains associate in groups to form microfibrils
9. microfibrils associate with other, non-cellulose polysaccharides, and are arranged in large bundles to form macrofibrils
10. this provides high tensile strength for structural support
11. made up of hundreds to thousands of monomers/ β-glucose joined together by β(1,4) glycosidic bond
12. allows formation of a large molecule, resulting in an insoluble material that can be used as structural support

(b) Outline the basis of the selective permeability of the cell membrane with reference to phospholipids, cholesterol and proteins. [8]

1. cell membrane is a phospholipid bilayer
2. it acts as a hydrophobic barrier / ref. to hydrophobic core
3. which prevents the diffusion of hydrophilic solutes / polar molecules, charged ions across it
4. weak hydrophobic interactions exist between phospholipids / ref. to lateral movement of phospholipids
5. creates transient gaps
6. for small, non-polar, hydrophobic solutes to diffuse across
7. the shorter length of fatty acid chains in phospholipids / higher degree of
8. unsaturated fatty acid chains in phospholipids leading to higher membrane permeability
9. presence of cholesterol in the membrane decreases the permeability of membrane
10. it does so by filling in spaces between hydrocarbon chains of phospholipids / plugging transient gaps
11. cholesterol regulates membrane fluidity / ref. to higher temperature, cholesterol decreases membrane fluidity / lower temperature, cholesterol increases membrane fluidity
12. hydrophilic solutes / polar molecules, charged ions can be transported across the membrane
13. through transport proteins
14. presence of carrier proteins
15. ref. to solute binding and change its 3D conformation

16. via facilitated diffusion / ref. to down a concentration gradient
17. via active transport / ref. to against a concentration gradient
18. presence of channel proteins
19. ref. to water-filled central pore / hydrophilic channel
20. via facilitated diffusion / ref. to down a concentration gradient

(c) Explain why animal cells mainly store lipids instead of carbohydrates. [6]

1. the absence of water of hydration in triglycerides fulfils the requirement for an animal's body mass to be kept to a minimum to facilitate locomotion
2. triglycerides do not affect water potential of cells when stored in large amounts
3. triglycerides are a good thermal insulator and hence a layer of fat beneath the skin (subcutaneous fat) insulates the body. This subcutaneous layer is especially thick in whales, seals and most other marine animals living in cold climates and is known as blubber
4. upon oxidation, triglycerides release a larger amount of energy per unit / ref. to one gram of fat releases more than twice as much energy (38 kJ / g) as a gram of carbohydrates (17 kJ / g)
5. being highly reduced molecules, triglycerides release more metabolic water when they are oxidised during cellular respiration compared to carbohydrates, which is extremely important to desert animals like camels
6. triglyceride can slide under pressure hence adipose tissue (which contains fats) around the vital organs helps to cushion and protect vital organs against physical impacts
7. being less dense than water, fats aid buoyancy of aquatic animals (e.g. blubber in whales)

[Total: 20]

QUESTION 6

(a) Describe and explain how the structure of the mitochondrion is adapted to ATP synthesis. [4]

1. inner mitochondrial membrane (cristae) is highly folded result in large surface area
2. allow the localization / embedding of more ATP synthase and electron carriers
3. inner mitochondrial membrane are impermeable to protons
4. and this allows the formation of electrochemical gradient / proton gradient across the membranes for ATP synthesis to occur

(b) Outline the main stages of the Krebs cycle and the role of its products in respiration. [8]

1. ref. to acetyl-CoA combines with oxaloacetate
2. a. ref. to decarboxylation reactions
   b. when citrate converted to α-ketoglutarate / α-ketoglutarate converted to succinyl-CoA
3. to produce 2 carbon dioxide / 2 C released
4. a. ref. to dehydrogenation reactions

b. when citrate converted to α-ketoglutarate / α-ketoglutarate converted to succinyl-CoA / malate is converted to oxaloacetate
c. when succinate is converted to fumarate

5. to produce reduced NAD / NADH
6. to produce reduced FAD / $FADH_2$
7. 1 molecule of ATP is produced
8. via substrate level phosphorylation
9. regeneration of oxaloacetate
10. NADH & $FADH_2$ passes electrons to electron transport chain / ref. to role in oxidative phosphorylation to generate proton gradient
11.

(c) Explain the production of a small yield of ATP from anaerobic respiration in both yeast and mammals. [8]

1. only glycolysis occurs
2. to produce two net molecules of ATP
3. by substrate-level phosphorylation
4. no oxygen to act as a final electron acceptor
5. ref. to electron transfer down electron transport chain does not occur
6. no regeneration of NAD
7. and subsequently the Krebs cycle stop
8. incomplete oxidation of glucose
9. pyruvate converted to ethanol and carbon dioxide in yeast
10. pyruvate converted to lactate in mammals
11. both processes NAD was regenerated

[Total: 20]