Name	Subject Class	Class	Candidate Number
	2BIX01		

ANGLO-CHINESE JUNIOR COLLEGE
Preliminary Examination 2018

BIOLOGY | **8876/02**
17 AUGUST 2018
HIGHER 1 | **2 hours**

Paper 2 Structured & Free-response Questions

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the top of this page.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.
No additional materials are required.

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.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6 or 7	
Total	**60**

This question paper consists of **16** printed pages.

For examiner's use

Section A

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

1 Cholesterol is synthesised in the smooth endoplasmic reticulum (SER) in liver cells by a series of enzyme-catalysed reactions. Cholesterol is then transported to the Golgi apparatus where they are packaged into vesicles and subsequently released into a membrane-bound duct of the liver.

Fig. 1.1 is an electron micrograph of a section of a liver tissue.

Fig. 1.1

(a) Name structure **T** in Fig. 1.1 and describe its role in liver cells.

____

____

____

____ [2]

For examiner's use

(b) Both prokaryotes and structure **T** have membrane proteins to help them perform the role described in (a). Suggest how prokaryotes perform this role.

[3]

(c) Explain how prokaryotes illustrate the cell theory.

[3]

[Total: 8]

2 Fig. 2.1 shows the stages involved in the synthesis of a protein in a eukaryotic cell.

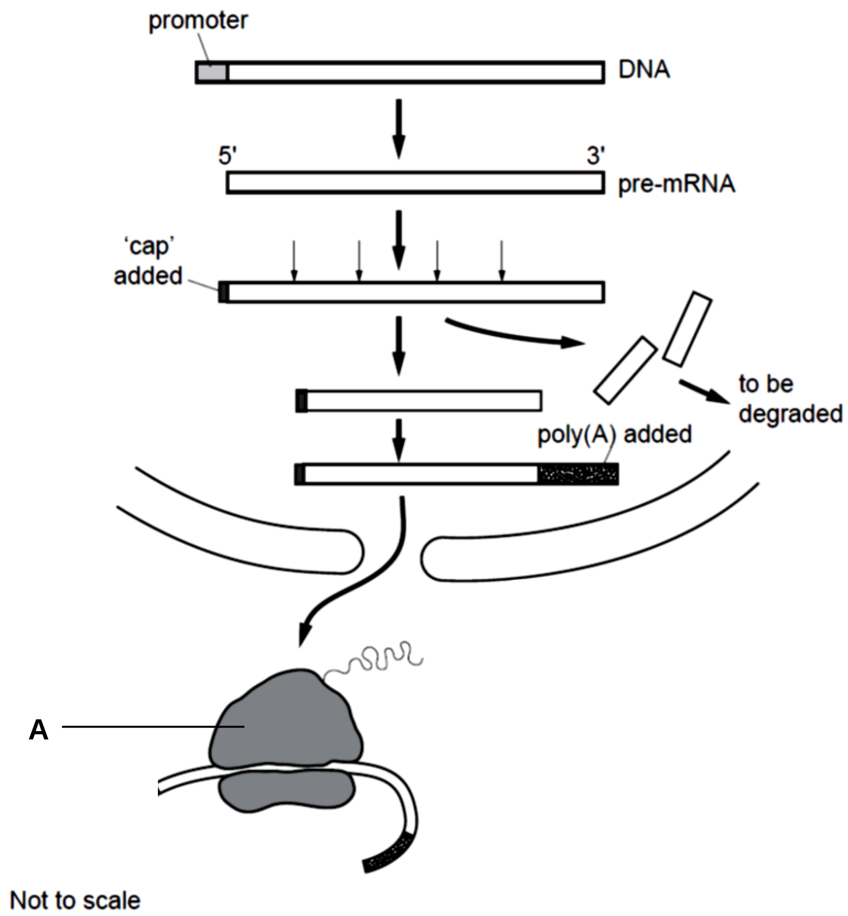

Fig. 2.1

(a) Describe the differences between the processes of protein synthesis in prokaryotes with that shown in Fig. 2.1.

....

....

....

.... [2]

For examiner's use

(b) Explain how the structure of organelle A is related to its function.

____ [4]

(c) Describe the formation of a bond found in both DNA & pre-mRNA.

____ [2]

[Total: 8]

For examiner's use

3 A study reported on the change in beetle sizes in a population due to climate change. Larger beetles are affected when compared to smaller beetles. This could be because larger beetles are less likely to get enough oxygen to sustain a higher metabolic rate caused by higher atmospheric temperatures. Fig. 3.1 shows the effect of a 2°C temperature rise on the size of larger and smaller beetles in a population over 100 generations.

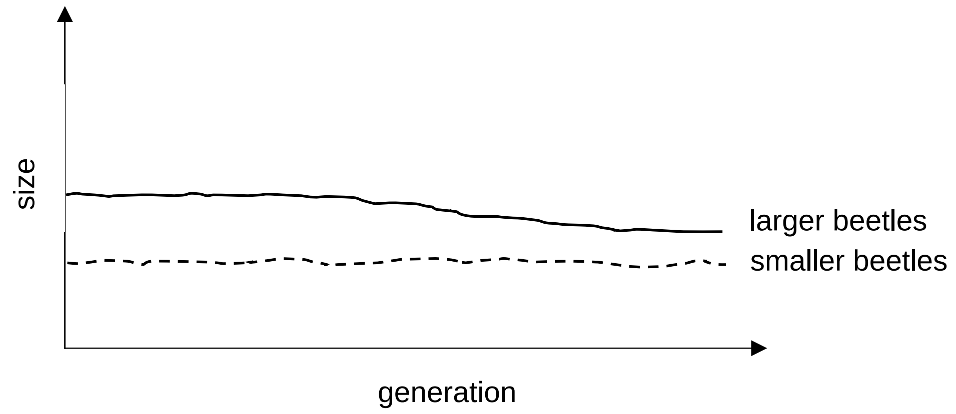

Fig. 3.1

(a) Define a 'population' of beetles.

[2]

(b) Explain how a temperature rise of 2°C in may cause a change in the gene pool of a population of beetles.

[4]

For examiner's use

(c) Comment on whether the alleles for large size in beetles will disappear from the population over time if temperature continues to increase as a result of climate change.

[2]

(d) Explain the consequences of a decrease in beetle size on the ecosystem.

[2]

[Total: 10]

4 Radish can have two different shapes – elongated or round. The colour of radish can be red, white or purple. These two traits are determined by two genes found on different chromosomes.

When a true-breeding plant with elongated and red radish was cross-fertilised with a true-breeding plant with round and white radish, all the resulting plants have elongated and purple radish.

(a) (i) Using appropriate symbols, construct a genetic diagram to show the expected F2 phenotypic ratio when the plants with elongated and purple radish are self-fertilised.

[5]

(ii) Each of the genes has only two allelic forms. Explain why the F2 phenotypic ratio does not follow the expected Mendelian ratio of 9:3:3:1.

[2]

(b) Suggest how the environment may affect the development of the colour of the radish.

[2]

[Total: 9]

5 Table 5.1 shows the range of optimal temperatures for the growth of some major crops in the state of Iowa, USA. These crops are generally grown in April and harvested in October where average temperatures are between 16ºC and 28ºC.

Table 5.1

Type of crop	Temperature/ ºC		
	Optimal	Minimum	Maximum
Corn	22 - 25	20	32 - 34
Wheat	20 - 25	5	38
Soybean	25 - 28	10 -14	37 - 40

(a) (i) With reference to Table. 5.1 and your knowledge of enzymes, explain why Iowa is suitable for the growth of these crops.

....

....

....

.... [2]

(ii) Suggest why corn productivity may be threatened by climate change.

....

....

....

....

....

.... [3]

The level of H_2O_2 is high in crops which are under environmental stress. Catalase is an enzyme found in crops which protect the cells from oxidative damage by breaking down hydrogen peroxide (H_2O_2) into water and oxygen. Fig. 5.1 shows the effect of increasing H_2O_2 concentration on the rate of reaction of catalase.

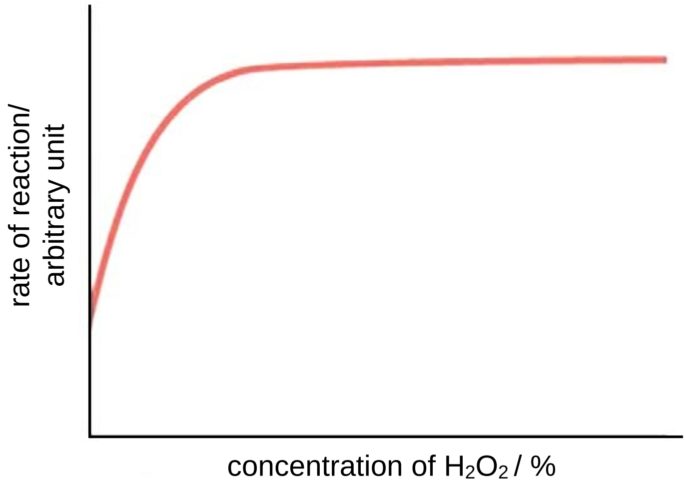

Fig. 5.1

(b) **(i)** With reference to Fig. 5.1, describe and explain the effect of increasing H_2O_2 concentration on the rate of reaction of catalase.

....

....

....

.... [2]

(ii) With reference to the information provided, suggest why the cells in soybean suffer from oxidative damage when the temperature reaches 38ºC.

....

....

....

....

....

.... [3]

[Total: 10]

For examiner's use

Section B

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

You answers must be in continuous prose, where appropriate.

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6 **(a)** Outline the processes resulting in chromosomal aberrations. [6]

(b) Discuss how the structures of biomolecules can account for their roles in plants. [9]

[Total: 15]

7 **(a)** Discuss the significance of the movement of substances across membranes to photosynthesis. [6]

(b) Outline the key features of stem cells which make them useful for research and medical applications, and discuss the ethical implications which may arise from these applications. [9]

[Total: 15]

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Fig. 1.1 is an electron micrograph of a section of a liver tissue.

Fig. 1.1

(a) Name structure **T** in Fig. 1.1 and describe its role in liver cells.

1. Structure T is the mitochondrion;

2. Site of ATP synthesis for synthesis of cholesterol/glycogen/proteins

OR intracellular movement of vesicles
OR secretion of lipoproteins via exocytosis
A! endocytosis/ active transport

[2]

(b) Both prokaryotes and structure **T** have membrane proteins to help them perform the role described in (a). Suggest how prokaryotes perform this role.

1. **Presence of electron carriers and ATP synthase;**
2. **Electron carriers use the energy from the transport of the electrons to pump H^+ across the membrane, generating a proton gradient;**
3. **ATP synthase which uses the energy of the proton gradient/proton motive force for chemiosmotic synthesis of ATP;**

[3]

(c) Explain how prokaryotes illustrate the cell theory.

Features of prokaryote	Cell theory
1. Prokaryotes are single-celled / unicellular;	**2. Cell theory states that all living things consist of cells;** **3. The cell is the smallest basic unit of life;**
4. Prokaryote undergoes binary fission/cell division/reproduction to give rise to more cells;	**5. All cells come from pre-existing cells**

[3]

[Total: 8]

For examiner's use

2 Fig. 2.1 shows the stages involved in the synthesis of a protein in a eukaryotic cell.

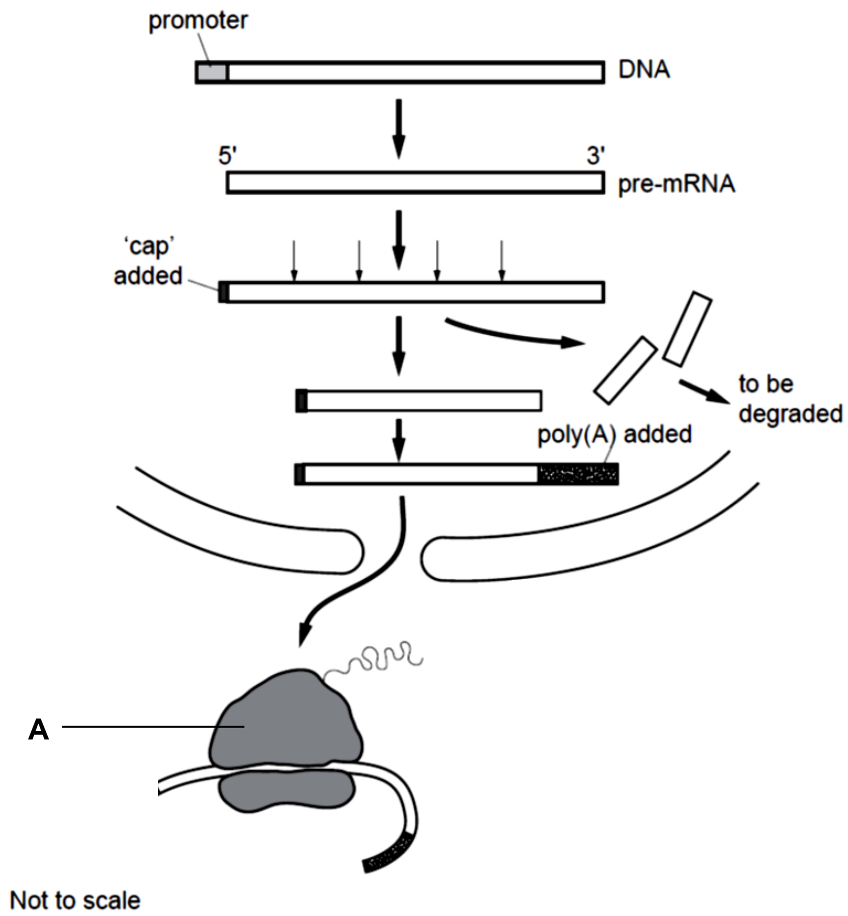

Fig. 2.1

(a) Describe the differences between the processes of protein synthesis in prokaryotes with that shown in Fig. 2.1.

1. In Fig 2.1, transcription occurs in the nucleus and translation occurs in the cytoplasm while in prokaryotes, both processes occur simultaneously in the cytoplasm;

2. ref to post-transcriptional modification (at least 1 e.g.);

e.g. In Fig 2.1, introns in the pre-mRNA are excised during RNA splicing to produce a mature mRNA while in prokaryotes, there is no RNA splicing.

e.g. In Fig 2.1, poly(A) tail/ 5' guanosine cap is added to pre-mRNA while in prokaryotes, no poly(A) tail/ 5' guanosine cap is added; [2]

For examiner's use

(b) Explain how the structure of organelle A is related to its function.

1. **The small subunit has a specific groove/ site that allows for mRNA to bind and be held in positioned during translation / align mRNA with tRNA;**
2. **The large subunit contains the A, P, E sites for aminoacyl-tRNA to be held in position;**
3. **Allowing anti-codon on tRNA to undergo complementary base pairing with the corresponding codons on the mRNA during translation;**
4. **Large ribosomal subunit / rRNA contains peptidyl transferase which catalyses the formation of peptide bond between adjacent amino acids during translation;**

[4]

(c) Describe the formation of a bond found in both DNA & pre-mRNA.

1. **Phosphate group at C5 of ribose forms a bond with OH group at C3 of the ribose of the next nucleotide;**
2. **Via a condensation reaction with the release of a water molecule;**
3. **Catalysed by an enzyme (polymerase);**

[2]

[Total: 8]

For examiner's use

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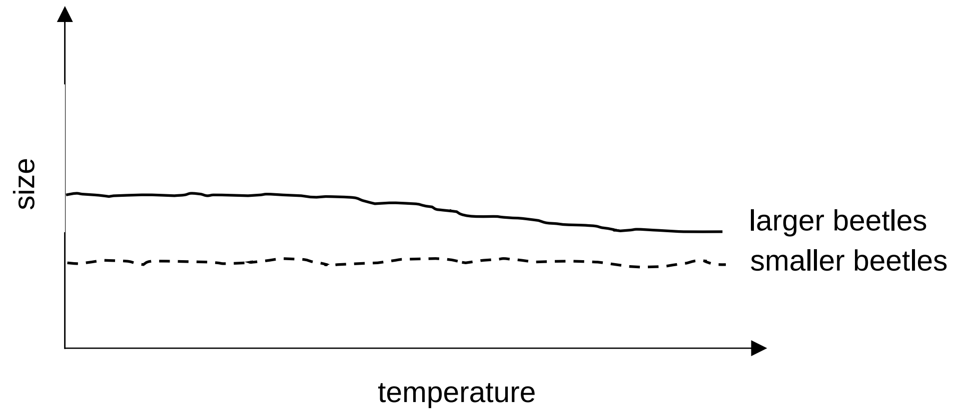

Fig. 3.1

(a) Define a 'population' of beetles.

1. **Population refers to a group of beetles living in the same area;**
2. **Belonging to same species (which can interbreed naturally to give viable, fertile offspring);**

[2]

(b) Explain how a temperature rise of 2°C in may cause a change in the gene pool of a population of beetles.

1. **Genetic variation in population expressed as phenotypic variation, i.e. range of sizes;**
2. **Higher temperature is the selection pressure;**
3. **Smaller beetles are selected for, resulting in more of these surviving and reproducing and passing on alleles coding for small size to their offspring;**
4. **Over time, gene pool changes where there is a higher frequency of alleles coding for smaller sizes in the population;**

[4]

For examiner's use

(c) Comment on whether the alleles for large size in beetles will disappear from the population over time if temperature continues to increase as a result of climate change.

1. **It will not as these alleles for large size may be recessive, and diploidy allows these alleles to exist in a heterozygote which is masked by a dominant allele**;
2. **It will not, as despite temperature rise, large size may still be selected for as such individuals may have a selective advantage during mating/ when foraging for food/preying on other beetles;**
3. **It will as allele for large size may be dominant and hence its phenotype will be expressed and subjected to natural selection, and be selected against;** [2]

(d) Explain the consequences of a decrease in beetle size on the ecosystem.

1. **Beetles are preyed upon, so less food for animals higher up in food chain;**
2. **Beetles act as dentritivores, smaller beetles mean slower rate of decomposition and hence recycling of nutrients;**
3. **Beetles can be pollinators of plants, so lower rate of pollination leads to reduction in certain plant populations/loss of certain plant species;**
4. **AVP;**

[2]

[Total: 10]

For examiner's use

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When a true-breeding plant with elongated and red radish was cross-fertilised with a true-breeding plant with round and white radish, all the resulting plants have elongated and purple radish.

(a) (i) Using appropriate symbols, construct a genetic diagram to show the expected F2 phenotypic ratio when the plants with elongated and purple radish are self-fertilised.

Appropriate symbols given:

Let L denotes the dominant allele coding for elongated shape
l denotes the recessive allele coding for round shape
C^R denotes the incompletely dominant allele coding for red colour
C^W denotes the incompletely dominant allele coding for white colour ;

F_1 phenotype: **elongated and purple radish**

F_1 genotype: **LlC^RC^W x LlC^RC^W ;**

F_1 gametes **(LC^R) (LC^W) (lC^R) (lC^W)   (LC^R) (LC^W) (lC^R) (lC^W) ;**

Punnett Square:

	LC^R	LC^W	lC^R	lC^W
LC^R	**LLC^RC^R Elongated and red**	**LLC^RC^W Elongated and purple**	**LlC^RC^R Elongated and red**	**LlC^RC^W Elongated and purple**
LC^W	**LLC^RC^W Elongated and purple**	**LLC^WC^W Elongated and white**	**LlC^RC^W Elongated and purple**	**LlC^WC^W Elongated and white**
lC^R	**LlC^RC^R Elongated and red**	**LlC^RC^W Elongated and purple**	**llC^RC^R Round and red**	**llC^RC^W Round and purple**
lC^W	**LlC^RC^W Elongated and purple**	**LlC^WC^W Elongated and white**	**llC^RC^W Round and purple**	**llC^WC^W Round and white**

;

F_2 phenotypic ratio - **3 elongated and red :**
6 elongated and purple :
3 elongated and white :
1 round and red :
2 round and purple :
1 round and white ;

[5]

For examiner's use

(ii) Each of the genes has only two allelic forms. Explain why the F2 phenotypic ratio does not follow the expected Mendelian ratio of 9:3:3:1.

1. The alleles for the radish colour display incomplete dominance, where there is an intermediate phenotype of purple colour;

2. This gives rise to more phenotypic combinations / Mendelian crosses are based on traits determined by genes that have alleles that display complete dominance;

[2]

(b) Suggest how the environment may affect the development of the colour of the radish.

1. Citing an environmental factor: Insufficient nutrients / sunlight;

2. Linking to an effect: insufficient pigments which results in pale / white radish even though it should be red or purple;

[2]

[Total: 9]

For examiner's use

5 Table 5.1 shows the range of optimal temperatures for the growth of some major crops in the state of Iowa, USA. These crops are generally grown in April and harvested in October where average temperatures are between 16ºC and 28ºC.

Table 5.1

Type of crop	Temperature/ ºC		
	Optimal	Minimum	Maximum
Corn	22 - 25	20	32 - 34
Wheat	20 - 25	5	38
Soybean	25 - 28	10 - 14	37 - 40

(a) (i) With reference to Table. 5.1 and your knowledge of enzymes, explain why Iowa is suitable for the growth of these crops.

1. **Data: Optimal temperatures of crops (corn is between 22 – 25ºC; wheat is between 20 – 25ºC, soybean is between 25 – 28ºC) fall in the temperature range of Iowa between 16ºC – 28ºC;**
2. **High enzymatic reactions at optimal temperatures and hence maximum growth/ yield of crops;**

[2]

(ii) Suggest why corn productivity may be threatened by climate change.

1. **Increased temperatures beyond the optimal temperatures for enzyme activity leading to denaturation of enzymes and hence, corn production drops;**
2. **Extreme weather events such as heatwaves/ droughts could lead to corn crops wilting;**
3. **High precipitation in the form of rainfall can cause nutrient leaching/ waterlogged soil/ plant decay;**

[3]

For examiner's use

The level of H_2O_2 is high in crops which are under environmental stress. Catalase is an enzyme found in crops which protect the cells from oxidative damage by breaking down hydrogen peroxide (H_2O_2) into water and oxygen. Fig. 5.1 shows the effect of increasing H_2O_2 concentration on the rate of reaction of catalase.

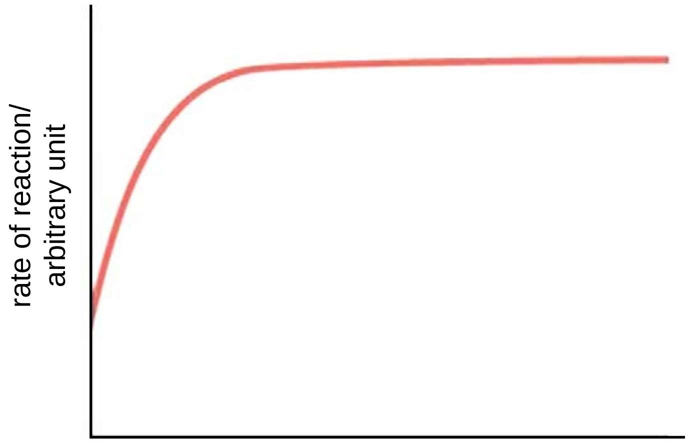

Fig. 5.1

(b) (i) With reference to Fig. 5.1, describe and explain the effect of increasing H_2O_2 concentration on the rate of reaction of catalase.

1. At low substrate concentrations, many of the available enzymes will have their active sites empty/unoccupied;

2. Hence, increasing substrate concentration increases the rate of reaction;

3. At high concentrations of substrate, the active sites are saturated/ not available with substrates, hence maximum rate of reaction;

[2]

(ii) With reference to the information provided, suggest why the cells in soybean suffer from oxidative damage when the temperature reaches 38ºC.

1. Temperatures of 38ºC at maximum temperature range of soybean (37 – 40ºC);

2. Some enzymes denature/ and (remaining) catalase activity at maximum;

3. Resulting in high concentrations of H_2O_2 which continue to cause cell damage;

[3]

[Total: 10]

For examiner's use

Section B

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7 **(a)** Discuss the significance of the movement of substances across membranes to photosynthesis. [6]

(b) Outline the key features of stem cells which make them useful for research and medical applications, and discuss the ethical implications which may arise from these applications. [9]

[Total: 15]

For examiner's use

6a)

1. **A chromosomal mutation can be due to change in the structure of a chromosome;**
2. **Can be brought about by deletion where breaks occur at two points along the length of a chromosome and the middle portion of the chromosome is lost;**
3. **inversion where breaks occur at two points along the length of a chromosome and the middle portion of the chromosome rotates through 180° before rejoining;**
4. **Translocation where a section of a chromosome breaks off and attaches to a non-homologous chromosome;**
5. **Duplication where a section of a chromosome replicates such that a set of gene loci is repeated;**

@ max 4

6. **A chromosomal mutation can be due to a change in the number of chromosomes;**
7. **Occurs due to spindle fibres not forming and attaching to kinetochore complex of chromosomes;**
8. **Non-disjunction during mitosis results in the daughter cells having one or more missing or extra chromosome(s)/ aneuploidy;**
9. **Sister chromatids of one or few chromosomes fail to separate during anaphase;**
10. **Non-disjunction in germ cells during meiosis results in the gametes having one or more missing or extra chromosome(s)/ aneuploidy;**
11. **One or several pairs of homologous chromosomes fail to separate during anaphase I/ chromatids of one or few chromosomes fail to separate during anaphase II;**
12. **Non-disjunction can occur on all the chromosomes within a nucleus during mitosis;**
13. **Non-disjunction of *all* the homologous pairs during anaphase I, or non-disjunction of chromatids of *all* the chromosomes during anaphase II/ polyploidy;**

@ max 4

14. **Give an example of a factor resulting in chromosomal aberration and explain why;**

QWC: Addresses both chromosomal structure and number aberrations.

For examiner's use

6b)

	Structure	Property	Role
PROTEINS			
A	1. Amino acids exist as zwitterions in neutral aqueous solutions	2. act as buffers in solution	keep pH in cells constant so cellular activities occur at optimum rate
B	3. A polypeptide is folded such that the bulk of the hydrophobic R-groups of amino acids/residues are buried in the interior while the hydrophilic R-groups pf amino acids/residues are on the outside, resulting in a globular shape	4. Soluble in water	Enzymes found in aqueous environment of cells to catalyse metabolic reactions
C	5. A polypeptide is folded such that the bulk of the hydrophobic R-groups of amino acids/residues are on the outside, allowing it to form hydrophobic interactions with hydrophobic hydrocarbon core in the phospholipid bilayer of the cell surface membrane OR A pore in the protein is lined with hydrophilic R-groups of amino acids/residues	6. Embedded in membrane OR Allows hydrophilic substances to pass through	Transmembrane protein allows transport of substances needed for cell process it e.g. water, ions to enter, and to leave, e.g. sucrose
CARBOHYDRATES			
D	7. Monosaccharides, i.e. glucose are small with many polar OH groups	8. Soluble in water	Glucose is a respiratory substrate of cellular respiration
E	9. Disaccharides, ie. sucrose are small with many polar OH groups	10. Soluble in water	Sucrose can be transported to different parts of plant via phloem
F	11. Each cellulose molecule contains about 10,000 residues, which make it a large molecule OR Most of the hydrophilic OH groups of the glucose residues are involved in forming cross-links with adjacent chains	12. Insoluble in water	Cellulose has a structural role as a component of cell wall, maintaining (any 1 pf the following) shape of cell/ allows turgidity to develop/ prevent osmotic lysis
G	13. Alternate β-glucose molecules are rotated 180° to form a straight chain, allowing cross-link of chains via hydrogen bonds between their OH groups, which are projected outwards on both sides of each chain OR	14. Increases compactness within the cellulose, resulting in tremendous tensile strength	

For examiner's use

	Cellulose chains are bundled to form microfibrils, which are further arranged in larger bundles to form macrofibrils **OR** **Macrofibrils are arranged in several layers in cell walls in a glue-like matrix made up of other polysaccharides**		
H	**15. The layers of cellulose are fully permeable to water and dissolved solutes and the gaps between layers of cellulose form channels, (and these channels can be filled with lignin)**	**16. allows for the passage of water and dissolved solutes** **(Lignified cellulose cell wall provides extra tensile strength e.g. in walls of xylem vessels)**	**Transport of substances through cell wall is important for the functioning of plant cells**
I	**17. Starch is composed of several hundreds or thousands of glucose molecules linked by glycosidic bonds**	**18. Upon hydrolysis, a large number of glucose molecules, which are the main respiratory substrates, are released to produce energy**	**Starch is a storage molecule**
J	**19. Starch is composed of several hundreds or thousands of glucose molecules linked by glycosidic bonds, so it is a large molecule** **OR** **For each molecule, most of the hydrophilic OH groups of the glucose residues project into the interior of the helices and form hydrogen bonds with one another**	**20. Insoluble in water** **OR** **They can be stored in large quantities without affecting the osmotic potential of cells / do not easily diffuse out of cells**	
K	**21. Starch is helical in structure, result in extensive coiling and entangling** **OR** **Amylopectin is highly branched**	**22. Allows molecules to be compacted, enabling more molecules to be stored in a given space, so greater amount of carbohydrates can be stored**	

For examiner's use

		per unit volume OR Allows many enzymes to act on it at any one time, so they can be hydrolysed to release glucose quickly, so that rate of respiration (i.e. ATP production) is increased	
LIPIDS			
L	23. Phospholipids: Two fatty acids + one phosphate group + one glycerol joined by ester bonds, and fatty acids may be saturated or unsaturated	24. Amphipathic nature allows formation of cell membranes (and glycolipids) OR Degree of saturation in fatty acid chains regulates fluidity of cell membrane	Phospholipid bilayer of cell membranes, allowing transport of selective substances OR Allows endocytosis/ exocytosis to take place
M	25. Triglycerides: Three fatty acids + one glycerol joined by ester bonds / linkages	26. Hydrophobic, thus insoluble in water	Energy storage
N	27. Carbon skeleton with four fused rings and hydroxyl group at one end	28. Hydrophobic and can be wedged between phospholipid molecules OR Regulates fluidity of cell membrane	
NUCLEIC ACIDS			
O	29. In DNA double helix, the complementary bases are held together by hydrogen bonds / the adjacent nucleotides within each strand are held together by strong covalent bonds, known as phosphodiester bonds, which are not easily broken / hydrophobic interactions between the stacked nitrogenous bases	30. Stabilise the structure of the double helix	Stores genetic information / template for reading of genetic information
P	31. Complementary base pairing, i.e. A to T/U, and C to G, via	32. Ensure accuracy/fidelit	

For examiner's use

	hydrogen bonds	y in synthesising molecules with complementary sequences in semi-conservative replication OR transcription OR translation (anti-codon-codon binding)	
Q	33. 4 bases, ATCG (AUCG)	34. Allows diversity of nucleotide sequences resulting in different proteins/products formed	
R	35. AVP		

QWC: covers at least 2 biomolecules

For examiner's use

7a)

1. **thylakoid membrane contains the electron transport chain, which is made up of electron carriers;**
2. **Energy from light raises energy level of electron (from special pair of chlorophyll a);**
3. **As it travels from one electron carrier to the next, the energy released is coupled to the pumping of H^+ through electron carriers via active transport;**
4. **from stroma to thylakoid space, hence creating a proton gradient across the membrane;**
5. **As H^+ flow down its gradient through ATP synthase via facilitated diffusion;**
6. **ADP is phosphorylated to form ATP in the stroma;**
7. **Which is required in the Calvin cycle for the reduction of PGA to form GALP;**
8. **GALP is converted to other forms of carbohydrates which the plant needs e.g. cellulose, sucrose etc and release into cytoplasm via facilitated diffusion;**
9. **Water transported into stroma via facilitated diffusion for photolysis;**
10. **Oxygen moved out of chloroplast via double membrane via diffusion to be removed;**

QWC: at least 1 example of how transport across membrane is linked to its significance

For examiner's use

7b)

Key features of stem cells	**Usefulness for research and medical applications**
1. They are unspecialised/ undifferentiated cells; **2. They are capable of dividing and renewing themselves for long periods via mitotic cell division / self-renewing;**	**3. Stem cells have been used to generate replacement of tissues and organs for transplant;**
4. They can differentiate into specialised cell types under presence of appropriate chemical signals.	**5. Stem cell research has enabled scientists to treat genetic disorders using somatic gene therapy;**

pt 1-5 (max 3m)

6. Most ethical issue arises from the derivation of stem cells especially ES cells;

7. Procedure of harvesting of ES cells is invasive and is akin to taking a human life;
8. An increased social tolerance to loss of life may pave the way for society to agree with controversial practises involving the termination of life;
9. Intentional creation of embryos with the intention of using them for research and destroying them in that process violates respect for nascent human life;

10. Medical risk of oocyte retrieval from the women / reducing the number and possibly the quality of remaining oocyte for future reproductive purposes;
11. Women may face an increasing risk of exploitation for research and commercial benefits;

12. Creation of ES cells using nonhuman oocytes may give rise to chimeras that appear part human and part animal and have characteristics of both humans and animals;

13. Informed consent of donors of surplus ES cell lines from frozen embryos from IVF may not be obtained or donors may not fully understand the implications of the donation / confidentiality of the donor may not be protected/ Patient may not fully understand the moral issue arising from the use of stem cell for their consent;
14. ES cells from donor may exhibit unknown long term effects that range from incompatibility to tumor formation in recipient and recipient may not fully understand the implications;

15. The implant of human stem cell into animals during experimentation may cause development of human part on animals;

pt 6-15 (max 5m)

16. QWC: Addresses both parts of the questions;