ANGLO-CHINESE JUNIOR COLLEGE
Preliminary Examination 2018

BIOLOGY **8876/01**

HIGHER 1 **28 August 2018**

Paper 1 Multiple Choice **1 hour**

Additional Material: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, pencil clips, highlighters, glue or correction fluid.
Write your name, centre number and index number on the Answer Sheet provided.

There are **thirty** questions in 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 answer sheet.

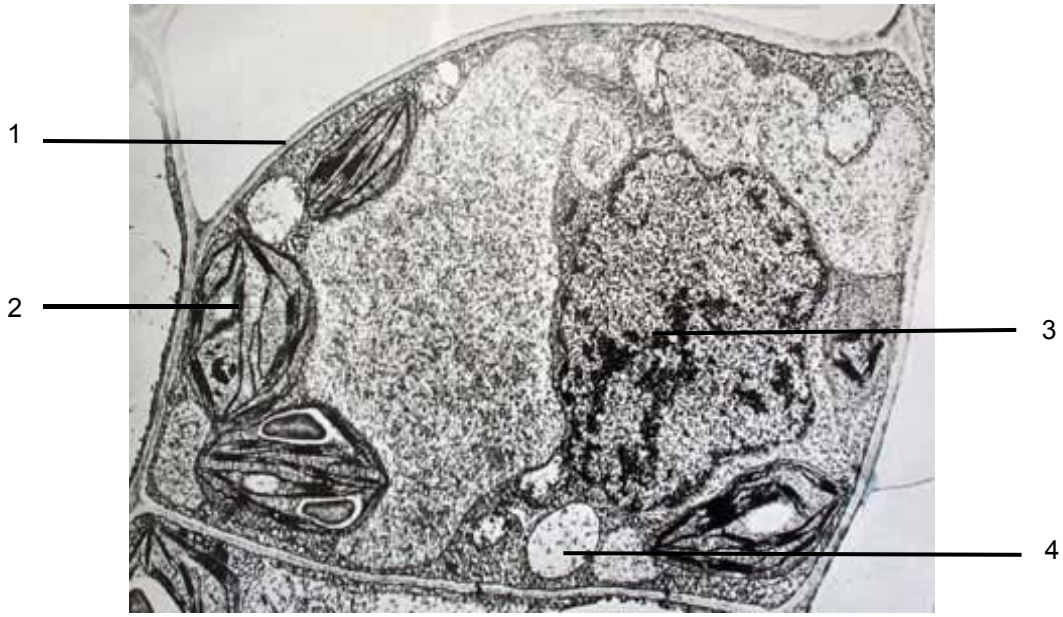
Read the instructions on the Answer Sheet very carefully.

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.

Calculators may be used.

This question paper consists of **19** printed pages.

1 The electron micrographs show two different types of cells (not shown to scale).



Cell A

Cell B

Which row matches the structures to their correct function?

	Structure in cell A	Structure in cell B	Function
A	3	7	Provide energy for the cells
B	1	5	Maintain the shape of the cells
C	2	6	Photosynthesize
D	4	6	Secrete proteins

2 The plasma membrane is the cell's protective barrier as it prevents foreign molecules from entering the cell. However, in drug research experiments, foreign molecules such as drugs or short DNA fragments need to be transported into the cell.

Electroporation is a technique used to increase the permeability of the membrane transiently by treating the cell with short electrical pulses.

Which statement most likely explains how electroporation works?

A The short electrical pulses denature the membrane proteins, allowing foreign molecules to pass through.

B The short electrical pulses cause the foreign molecules to be attracted to the surface of the membrane.

C Electricity increases the hydrophobic nature of foreign molecules, allowing them to pass through the hydrophobic core of the phospholipid membrane.

D Electroporation causes the phospholipids to move apart to create pores for foreign molecules to pass through.

3 Some students came up with possible explanations of how proteins are secreted out of a prokaryotic cell.

Which is the best explanation?

A Proteins diffuse through the plasma membrane out of the cell.

B Protein channels allow proteins to pass through the plasma membrane.

C Exocytosis occurs when vesicles within the cell fuse with the plasma membrane.

D Prokaryotic cells lyse in order to release proteins into the environment.

4 Which row matches the descriptions of biological molecules to where they are found?

1 Polymer of glucose molecules linked by β-1,4 glycosidic bonds to form a straight chain

2 An unbranched and helical polymer of glucose molecules linked by α-1,4 glycosidic bonds

3 An amphipathic, phosphate-containing molecule

	1	2	3
A	Cell wall of eukaryotes only	Storage granules in animal cells	Plasma membrane of prokaryotes and eukaryotes
B	Cell wall of prokaryotes and eukaryotes	Storage granules in plant cells	Plasma membrane of eukaryotes only
C	Cell wall of prokaryotes and eukaryotes	Storage granules in animal cells	Plasma membrane of prokaryotes only
D	Cell wall of eukaryotes only	Storage granules in plant cells	Plasma membrane of prokaryotes and eukaryotes

5 How many of the following descriptions correctly relates the structure of a globular protein to its property?

1 Monomers are linked by peptide bonds to prevent the protein from denaturing

2 Amino acid residues with hydrophilic R groups face the exterior of the protein, allowing it to be soluble in water

3 Many hydrogen bonds present allow the protein to have high tensile strength

4 Bonds between the subunits of the protein allow it to be stored easily

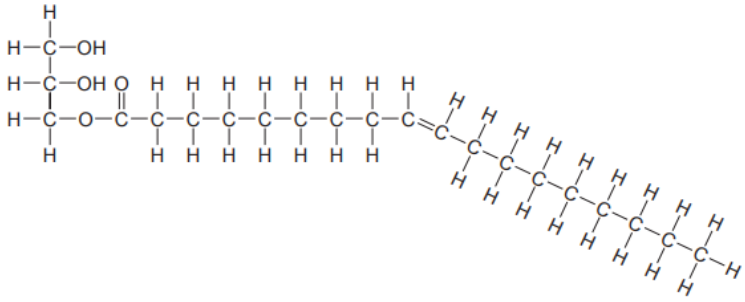
A 0

B 1

C 2

D 3

6 The diagram shows a molecule that has been partially broken down.



This molecule was then completely digested in a further reaction.

Which row correctly matches the products to the reaction?

	Reaction	Products
A	Condensation reaction involving the addition of a water molecule	Glycerol, saturated fatty acid
B	Condensation reaction involving the removal of a water molecule	Glycine, unsaturated fatty acid
C	Hydrolysis reaction involving the addition of a water molecule	Glycerol, unsaturated fatty acid
D	Hydrolysis reaction involving the removal of a water molecule	Glycine, saturated fatty acid

7 Which statement is correct regarding the enzymatic activity of catalase under the following conditions?

1 Addition of a non-competitive inhibitor

2 Addition of pH13 buffer solution

3 Incubation at 10°C

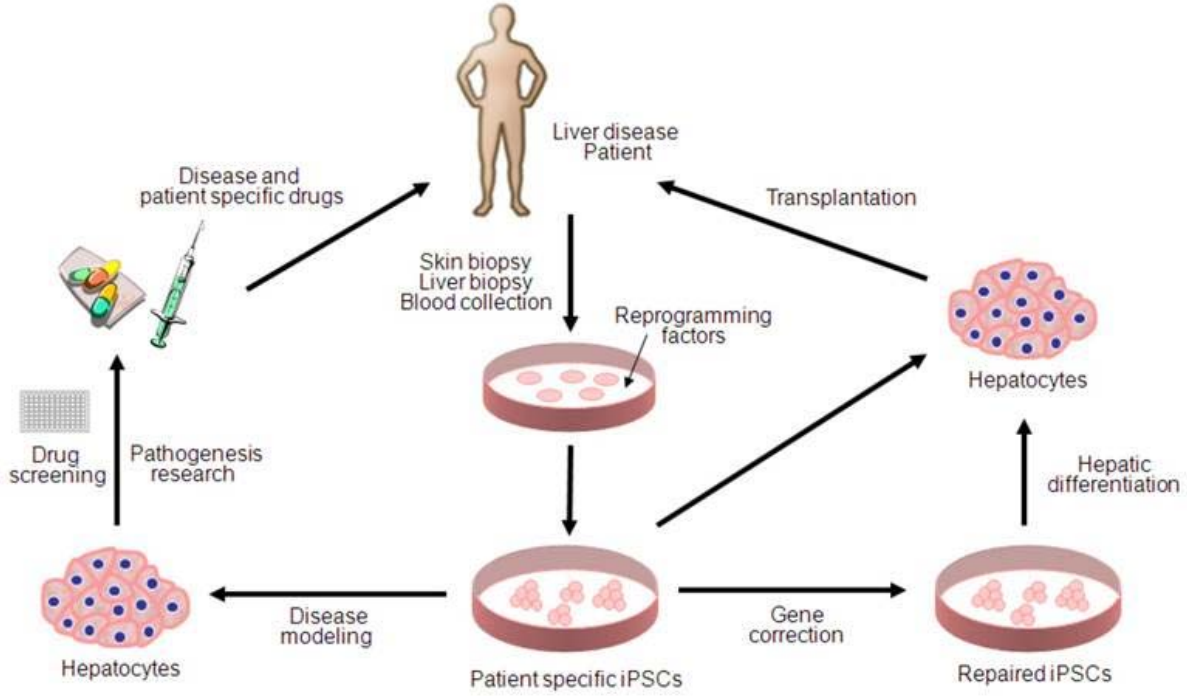
A The hydrogen and ionic bonds between R groups of residues are broken in conditions 2 and 3, hence the rate of reaction decreases.

B The catalytic and binding residues in all active sites are affected in condition 1, hence the rate of reaction decreases.

C The chances of effective collisions to form enzyme-substrate complexes are low in condition 3, hence the rate of reaction decreases.

D The changes in the 3D conformation of enzymes are irreversible in conditions 1, 2 and 3, hence the rate of reaction decreases.

8 Induced pluripotent stem cells (iPSCs) are useful in regenerative medicine as they act as an effective replacement for human embryonic stem cells. The figure shows the potential applications of human iPSCs for liver diseases, such as disease modelling, drug discovery and cell replacement therapy.



Which statement could be concluded from the information provided?

A As iPSCs are obtained and reprogrammed from somatic cells of the patient, the patient-specific iPSCs are genetically identical to the somatic cells.

B The drawback of using iPSCs is that somatic DNA mutations remain in the original differentiated cells and these may potentially affect cellular function.

C It is easier to obtain iPSCs compared to embryonic stem cells as iPSCs can be obtained from any differentiated somatic cell while embryonic stem cells can only be obtained from the inner cell mass of the blastocyst.

D The reprogramming factors used to obtain patient specific iPSCs are transcription factors that induce the patient's cells to express genes that are characteristic of pluripotent stem cells.

9 Which statements regarding stem cells are true?

1 Researchers can induce embryonic stem cells to differentiate into various cells and tissue types to repair damaged tissue.

2 The use of embryonic stem cells for research can be an ethical challenge as the continued destruction of embryos could desensitise medical communities to the destruction of life.

3 One of the normal functions of blood stem cells in a living organism is the transplantation of such stem cells from normal healthy bone marrow donors to leukemia patients for treatment.

4 Blood stem cells can potentially differentiate into neurones under appropriate chemical signals.

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

10 Which statement(s) about DNA polymerases and RNA polymerases is/ are correct?

1 They read the DNA template in the 3' to 5' direction.

3 They unwind and unzip double-stranded DNA.

3 They read the terminator sequence and stop adding nucleotides to nucleic acid chains.

4 They bind to the same specific sequences to start their processes.

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

11 The following steps describe a method to study the structure and localisation of protein kinase c in yeast cells.

- tRNAs with anticodon AAG were isolated and chemically modified to carry their specific fluorescent amino acids.
- During translation, chemically modified amino-acyl tRNAs bind to the large ribosomal subunit.
- Fluorescent amino acids are incorporated into the elongating polypeptide chain.
- After translation, the polypeptide chain folds into its native conformation and the positions of the fluorescent amino acids can be detected and studied.

Which of the following describes a condition which will allow the above method to be carried out?

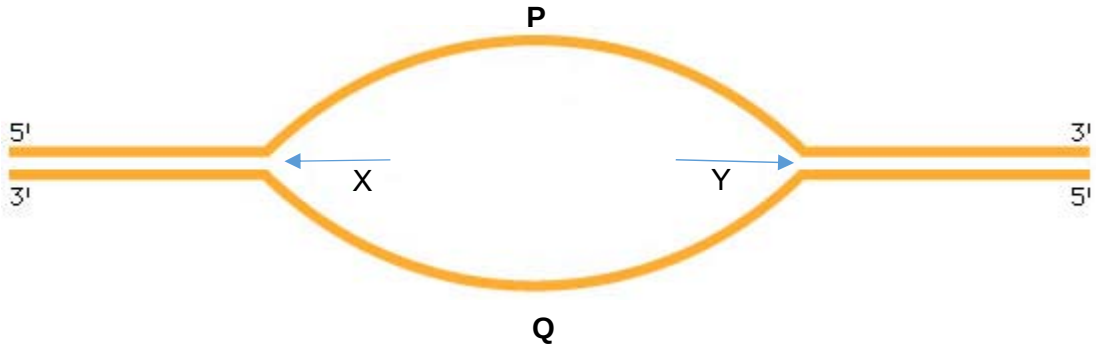
A Peptidyl transferase is specific to the fluorescent amino acid and the elongating polypeptide chain in order to catalyse the formation of a peptide bond.

B Synthetic amino-acyl tRNA synthetase is specific to the fluorescent amino acid and chemically modified tRNA in order to form modified amino-acyl tRNA.

C The ribosome is specific to the mRNA sequence in order to synthesise protein kinase c.

D Chemically modified amino-acyl tRNA is specific to the P site of a large ribosomal subunit in order to add the fluorescent amino acid to the elongating polypeptide chain.

12 Which statement describes the process shown?



A Both DNA template strands P and Q are used to synthesise leading strands towards direction X.

B Both DNA template strands P and Q are used to synthesise leading strand and lagging strand respectively towards direction X.

C The DNA daughter strand synthesised using template strand P has only one primer while the daughter strand synthesised using DNA template strand Q has multiple primers.

D As the replication fork opens towards direction Y, more Okazaki fragments are synthesised using DNA template strand Q.

13 The following table shows the codons and their corresponding amino acids.

	U	C	A	G	
U	UUU Phe UUC UUA Leu UUG	UCU UCC UCA Ser UCG	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	U C A G
C	CUU CUC CUA Leu CUG	CCU CCC CCA Pro CCG	CAU His CAC CAA Gln CAG	CGU CGC CGA Arg CGG	U C A G
A	AUU AUC Ile AUA AUG	ACU ACC ACA Thr ACG Met	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG	U C A G
G	GUU GUC GUA Val GUG	GCU GCC GCA Ala GCG	GAU Asp GAC GAA Glu GAG	GGU GGC GGA Gly GGG	U C A G

The DNA sequence is taken from part of a gene:

…TAC GTT AAT AAC CCT GAG GGC TAA TGT…

Which of the following mutations will result in the same phenotype as the original sequence?

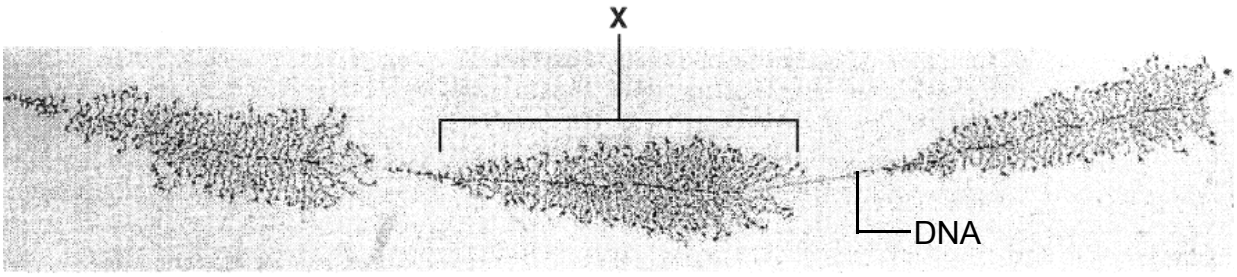
A …TAC GTG ATT AAC CCT GAG GGC TAA TGT…

B …TAT GTT AAT AAC CCT GAG GGC TAA TGT…

C …TAC GTT AAT AAC CCT GAG GGC TAA TTT…

D …TAC GTC AAT AAC CCT GAG GGC TAA TGT…

14 A process known as DNA amplification increases the number of rRNA genes in frog eggs before fertilisation. The figure shows the transcription of the genes coding for rRNAs at adjacent positions along the chromosome.



Which of the following statements could **not** account for structure X?

1 Elongating polypeptide chains form structure X as ribosomes read the mRNA strand.

2 Structure X is thicker on the right side as RNA polymerase reads the template strand from left to right.

3 There are multiple pre-mRNAs synthesized simultaneously in structure X as there are many promoters.

4 Structure X is highly condensed heterochromatin.

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

15 Elephants have been found to be resistant, though not immune, to cancer. They are four times less likely to develop cancer as compared to humans. Elephants have 40 copies of the *p53* gene while humans only have two. In addition, three genes which code for DNA repair proteins have been found to be very active.

What do these observations suggest?

A All DNA mutations in the elephant are repaired.

B When elephants develop cancer, it is due to environmental causative factors such as excessive exposure to UV light.

C The occurrence of cancer is due to the *p53* oncogene, which stimulates the cell to divide rapidly, bypassing the cell cycle checkpoints.

D There is large amount of p53 proteins in an elephant cell which prevent cells with mutations from moving past the cell cycle checkpoints.

16 A species of lizards, Whiptail lizards, reproduce only by parthenogenesis. This mode of asexual reproduction allows females to produce offspring alone, without the genetic contribution of a male.

Scientists are worried that this species may become endangered as a result of climate change.

Which statements support the scientists' concerns?

1 Offspring of parthenogenetic species are genetically identical.
2 Parthenogenesis produces too few offspring for a viable population.
3 Genetic contribution of a male is required in order for the offspring to survive.
4 In asexual reproduction, meiosis does not occur to produce genetically different gametes.

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

17 A student examined a slide of an onion root tip and obtained the following results.

Stage	Number of cells
Interphase	886
Prophase	73
Metaphase	16
Anaphase	14
Telophase	11

What percentage of the cells contain chromosomes that do not appear as sister chromatids?

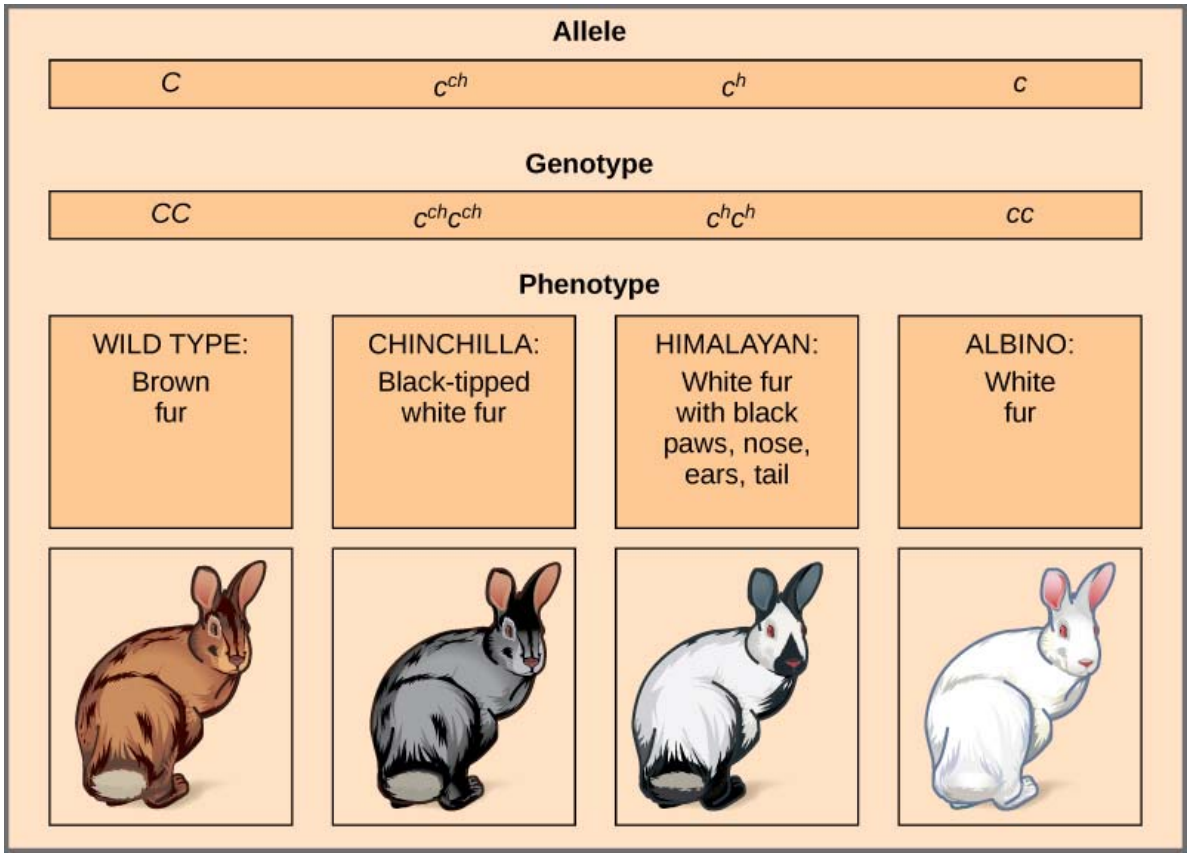
A 95.9%

B 91.1%

C 88.6%

D 2.5%

18 Rabbits carry the *C* gene which is required for the development of pigments in their fur. The alleles show a hierarchy of dominance when present in heterozygous individuals as shown in the figure. The order of dominance of these alleles, in descending order, is C, c^{ch}, c^{h}, c.



A scientist observed that the fur on the paws, noses and ears of Himalayan rabbits tends to be black while the rest of its body tends to be white. The scientist extracted a section of skin from the ear of a Himalayan rabbit and cultured the follicle cells. He discovered that when the cells are exposed to temperatures between 15°C and 25°C, they synthesise certain pigments. However, at temperatures beyond 35°C, these pigments are not synthesised.

Which statement best explains the results of the scientist's experiments?

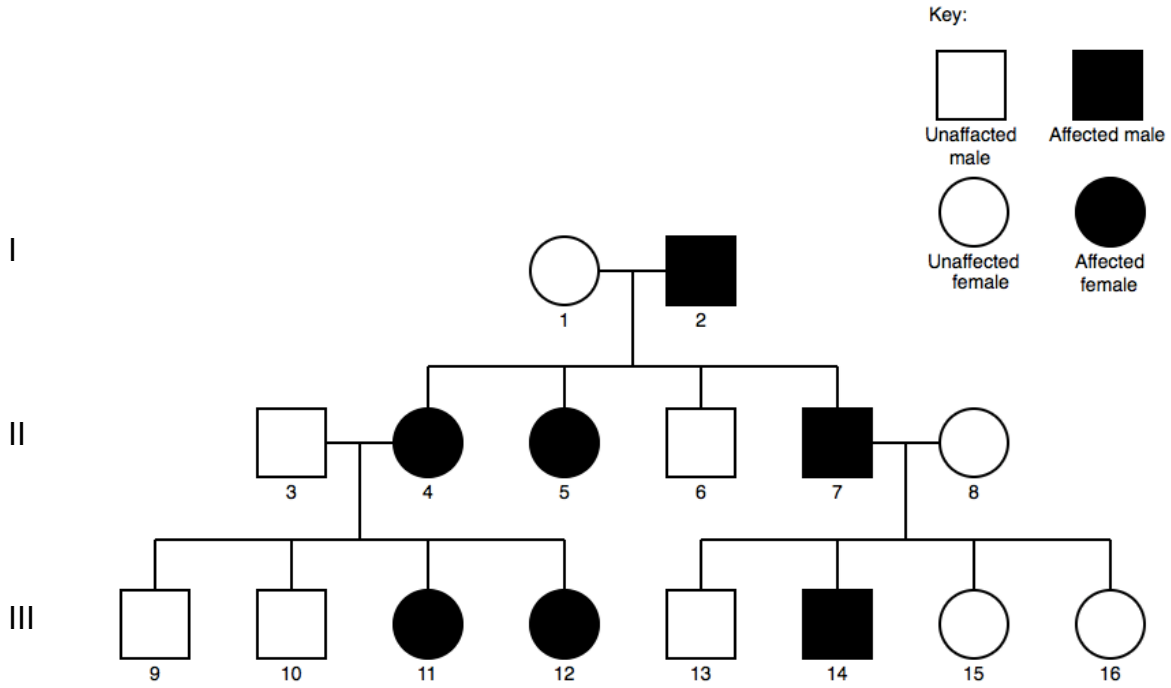
A Temperatures beyond 35°C alter the structure of the pigments produced by the skin cells, hence the rest of the Himalayan rabbit's body tends to be white.

B The Himalayan phenotype is a result of the c^{h} allele that produces a temperature-sensitive gene product which controls the production of the pigments.

C Multiple alleles of the *C* gene can give rise to white fur with black patches or white fur under different temperatures.

D The Himalayan phenotype is an example of incomplete dominance where it is an intermediate of the chinchilla ($c^{ch}c^{ch}$) and albino (cc) genotypes.

19 The diagram shows the pedigree for the inheritance of polycystic kidney disease which is hereditary.



Assuming that the letters R and r denote dominant and recessive alleles respectively, what is the mode of inheritance for this disease and the possible genotype of individual 11?

	Mode of inheritance	Genotype of individual 11
A	Autosomal dominant	RR
B	Autosomal recessive	rr
C	X-linked dominant	$X^R X^r$
D	X-linked recessive	$X^r X^r$

20 An organism is heterozygous at four gene loci on different chromosomes. Its genotype is AaBbCcDd.

What is the chance that a particular gamete from this organism has the genotype abcd?

A 1 in 2

B 1 in 4

C 1 in 8

D 1 in 16

21 The electron micrograph shows structures found in a cell.

Which row matches the events occurring at the labelled structures?

	X	Y	Z
A	ADP + Pi → ATP	ADP + Pi → ATP	$NADPH \rightarrow NADP^+ + H^+ + 2e^-$
B	ATP → ADP + Pi	ATP → ADP + Pi	$NADP^+ + H^+ + 2e^- \rightarrow NADPH$
C	$NAD^+ + H^+ + 2e^- \rightarrow NADH$	$H_2O \rightarrow 2H^+ + 2e^- + ½\ O_2$	CO_2 + RuBP → 2PGA
D	$FAD + 2H^+ + 2e^- \rightarrow FADH_2$	$2H^+ + 2e^- + ½\ O_2 \rightarrow H_2O$	Acetyl CoA + Oxaloacetate → Citrate

22 Photophosphorylation in the chloroplasts of plant cells results in the synthesis of ATP. Which processes require the use of ATP formed from photophosphorylation?

1 Formation of triose phosphate sugars for the biosynthesis of glucose.
2 Activation of glucose in glycolysis, so that it can be used in further reactions.
3 Regeneration of RuBP, the starting compound of the Calvin cycle.
4 Secretion of cellulose which makes up the plant cell wall.

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

23 Through a series of energy transfers, chemiosmosis results in the generation of ATP during aerobic respiration and photosynthesis.

Which of the following describe the conditions necessary for the chemiosmotic synthesis of ATP in both processes?

1 The transport of a lipid-soluble molecule against its concentration gradient.
2 The presence of oxygen as a final electron and proton acceptor.
3 The impermeability of the phospholipid bilayer to substances which are polar or charged.
4 The transmembrane nature of electron carrier proteins.
5 The provision of a pore which allows the facilitated diffusion of molecules.

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

24 During an investigation on the process of cellular respiration, scientists isolated different components of a cell and placed them into different tubes as follows:

Tube 1: Cytoplasm only
Tube 2: Intact mitochondria only
Tube 3: Mitochondrial matrix only
Tube 4: Cytoplasm and intact mitochondria

Excess glucose is added to each of the tubes and incubated for one hour. Which of the tubes would have a continuous production of ATP during the incubation period?

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

25 Due to various human activities, there are many species that have become endangered. As these species face a reduction in population size, they are at risk of becoming extinct. It is found that the endangered species lose their genetic variation as the population size is reduced. Should the endangered population size increase, the genetic variation will not increase much within the next hundred years.

Which of the following statements is **not** true?

A A population would need to accumulate many heritable mutations over many generations in order to increase its genetic variation.

B As the population size of the endangered species is reduced, there will be a loss of alleles due to the death of the individual organisms.

C Epidemics could kill the endangered species easily as the population has low genetic variation, increasing their chance of extinction.

D As the population size is reduced, sexual reproduction with random mating within the endangered species will increase heterozygosity, resulting in higher relative fitness in the population.

26 Which of the following statement(s) explain(s) why population is the smallest unit that can evolve?

1 Selection pressures at a particular location where the population is living in, will result in the survival of the fittest.

2 An individual may accumulate genetic changes within its lifetime.

3 Natural selection changes the frequency of alleles within a population.

4 Natural selection will induce mutations in the individual so as to allow adaptation.

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

27 A population of green anole lizards (*Anolis carolinensis*) is native to the trees in Florida in the United States of America (USA). They tend to occupy the lower branches of the trees which are thicker, instead of the higher branches which are thinner and snap more easily.

In the 1950s, the brown anole lizards (*Anolis porcatus*) from Cuba were introduced into Florida. These lizards are larger and heavier than the green anole lizards and also prefer the lower branches. Both the green and brown anole lizards feed on flying insects that fly around the branches. The adults of both species also tend to feed on the hatchlings of the other species.

Studies have shown that after 20 years, the green anole lizards have occupied the higher branches. Their toe pads are also larger than before, with sticky scales so that they can perch on the higher branches.

Which statement best explains how the evolution of the green anole lizard in Florida has occurred?

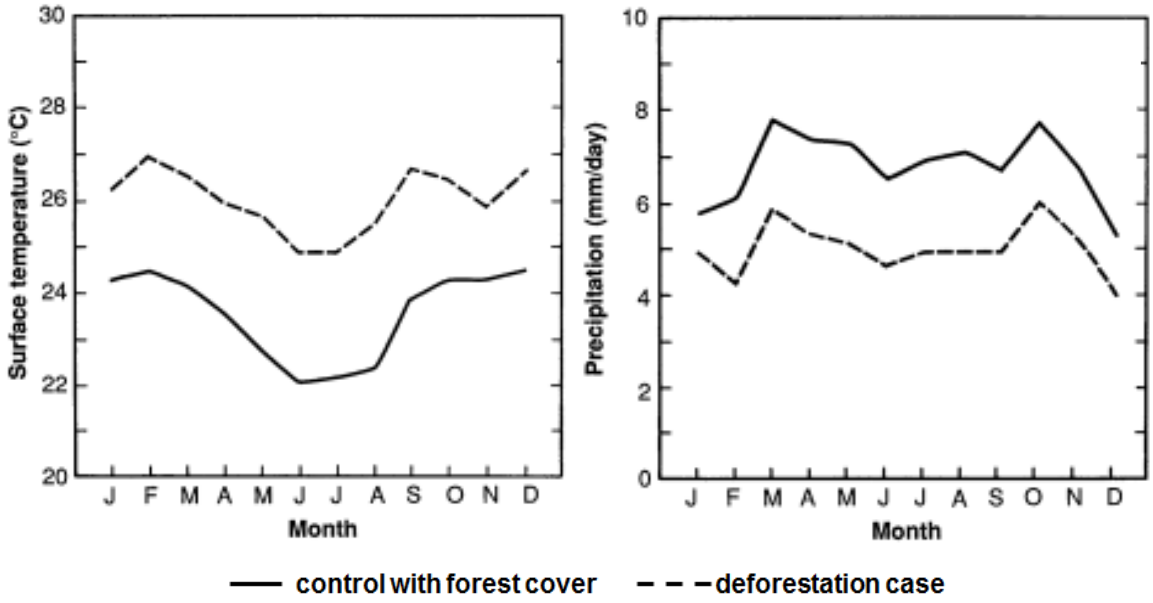
A Mating between the green and brown anole lizards during the 20 years results in the green anole lizards having larger toe pads and sticky scales, on which natural selection could act upon.

B Within the original green anole lizard population, there were some individuals that already had larger toe pads and sticky scales, on which natural selection could act.

C Green anole lizards climbed onto higher branches as the brown anole lizards could not do so.

D Green anole lizards which live longer usually leave more offspring since they have more reproductive opportunities.

28 Scientists created a simulation of the effects of Amazon deforestation on the climate. In the simulation, an area of the tropical forest was replaced by a pasture of grass. The simulation provided monthly data on the temperature of the ground surface (surface temperature) and rainfall (precipitation) over a year-long period.



Which statements could explain these data?

1 Grass is a more effective carbon sink than trees.

2 The removal of forest cover disturbed the soil layers and resulted in carbon emissions.

3 Without the trees, the reduced transpiration rate resulted in less water vapour released into the atmosphere.

4 Increase in surface temperature could lead to increase in the rate of evaporation.

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

29 Which row correctly matches the human activity to its corresponding effect due to climate change?

	Human activities	**Effects**
A	Over-hunting of animals	Reduction in biodiversity
B	Usage of more cars	More wild animals killed on the expressways
C	Burning of forests in West Sumatra, Indonesia	Heavy rains and heat waves in different parts of the world
D	Pollution from toxic runoff from factories	Bleaching of coral reefs

30 Which of the following consequences resulted from an increase in global temperatures?

1 Many populations of the European butterfly species moved northwards by 35 – 240km.

2 *Aedes aegypti*, previously limited to low-lying areas, is observed at 2200m above sea level in Colombia.

3 Malaria is a growing public health threat to residents in the highlands.

4 Insect species in the higher latitudes increased their reproductive rate.

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

H1

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

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]

For examiner's use

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

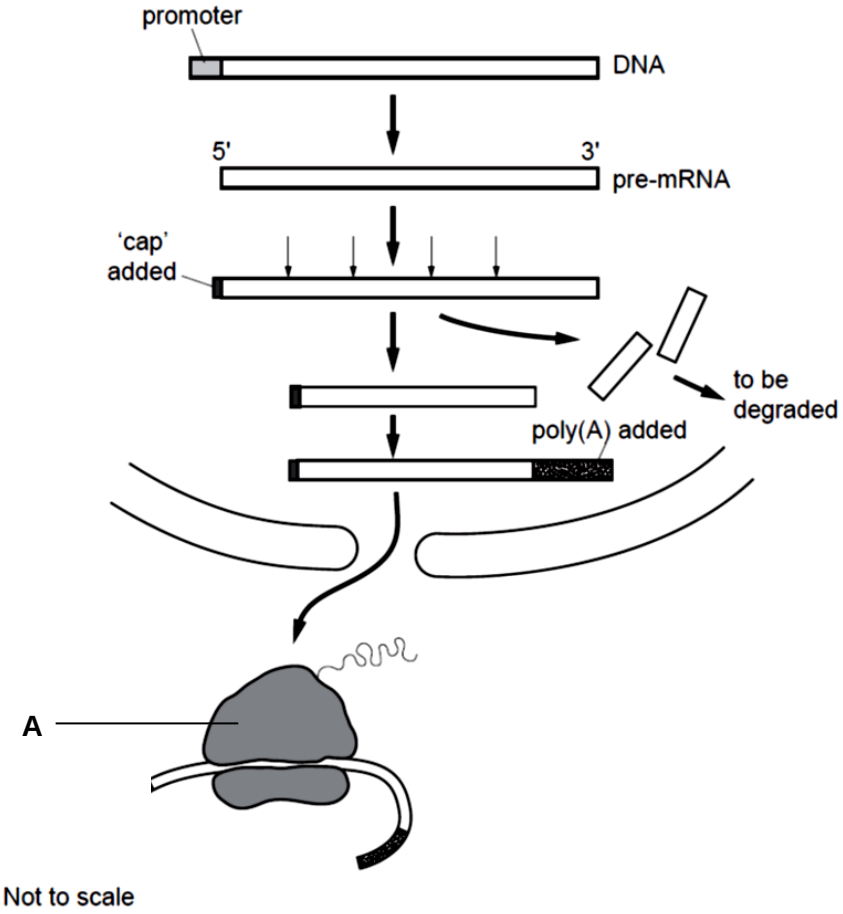


Fig. 2.1

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

[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.

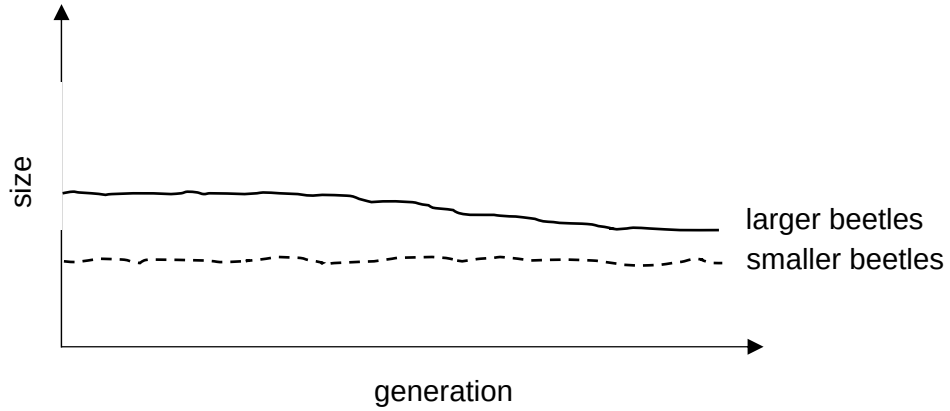


Fig. 3.1

(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]

For examiner's use

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]

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.

.....

.....

.....

[2]

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

.....

.....

.....

.....

.....

[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.

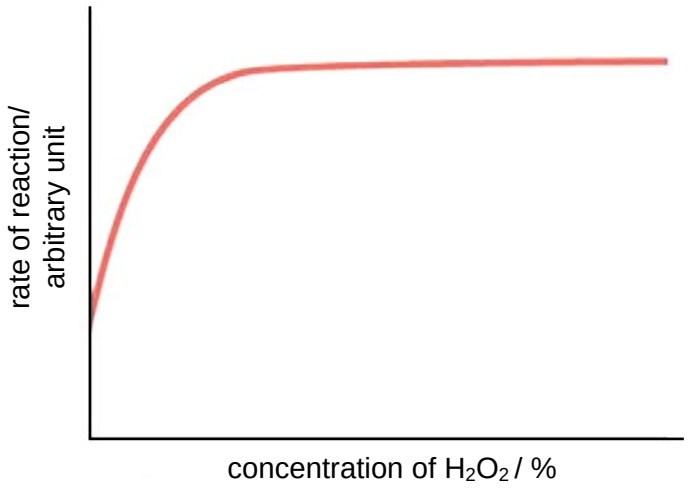


Fig. 5.1

(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.

.....

.....

.....

.....[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.

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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]

For examiner's use

For examiner's use

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.

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]

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.

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]

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

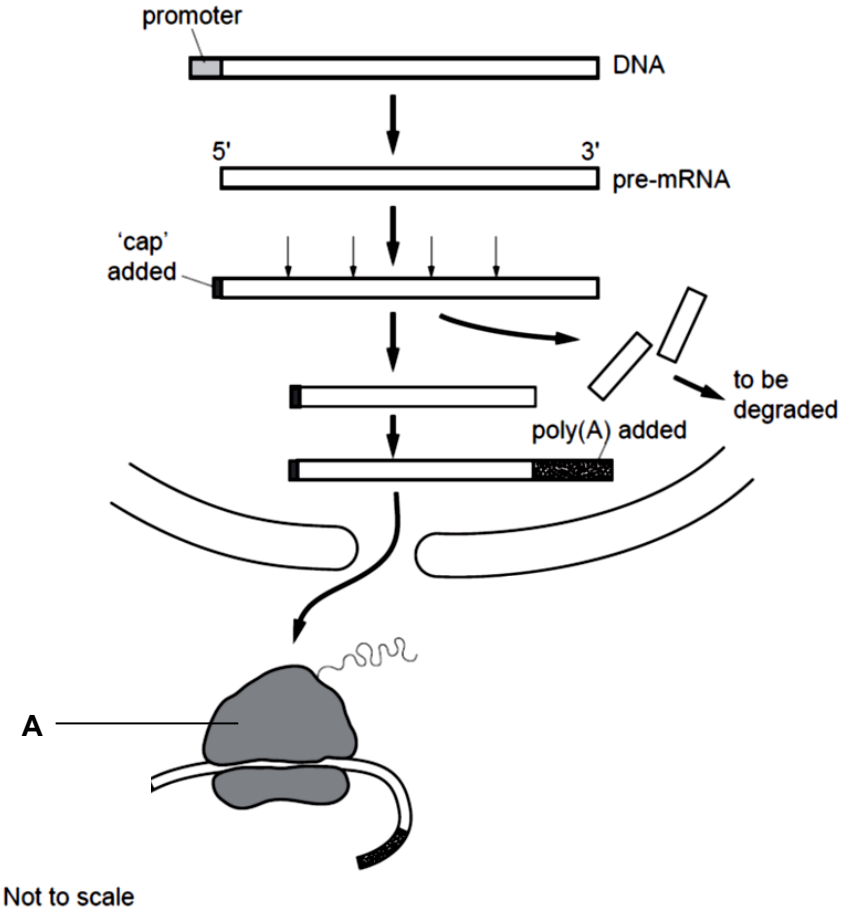

Fig. 2.1

(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

3 A study reported on the change in beetle sizes in a population due to climate change. Larger beetles appear to be 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.

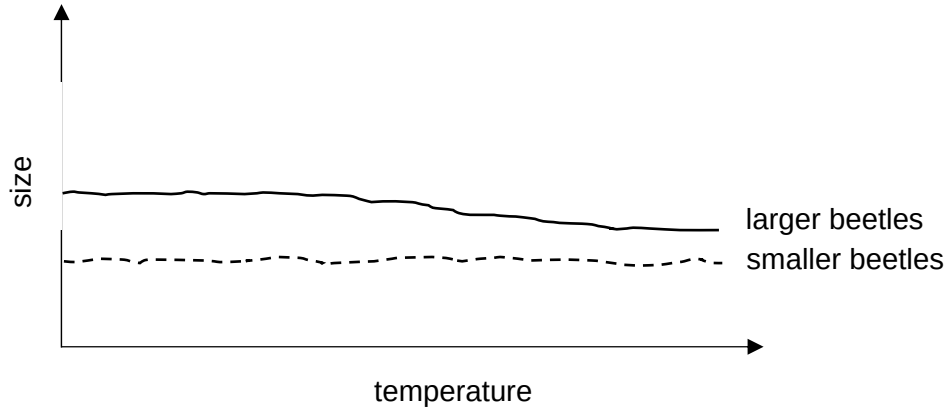

Fig. 3.1

(a) Define a 'population' of beetles.

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

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.

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: **LIC^RC^W x LIC^RC^W ;**

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

Punnett Square:

	(LC^R)	(LC^W)	(IC^R)	(IC^W)
(LC^R)	**LLC^RC^R Elongated and red**	**LLC^RC^W Elongated and purple**	**LIC^RC^R Elongated and red**	**LIC^RC^W Elongated and purple**
(LC^W)	**LLC^RC^W Elongated and purple**	**LLC^WC^W Elongated and white**	**LIC^RC^W Elongated and purple**	**LIC^WC^W Elongated and white**
(IC^R)	**LIC^RC^R Elongated and red**	**LIC^RC^W Elongated and purple**	**IIC^RC^R Round and red**	**IIC^RC^W Round and purple**
(IC^W)	**LIC^RC^W Elongated and purple**	**LIC^WC^W Elongated and white**	**IIC^RC^W Round and purple**	**IIC^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]

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

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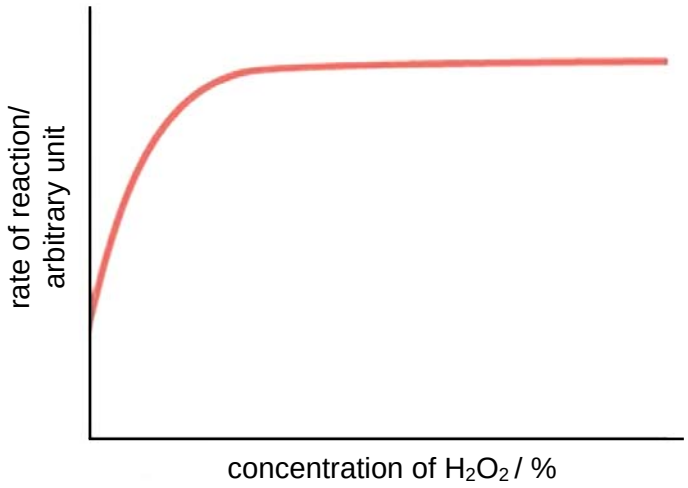

Fig. 5.1

(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

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[Total: 15]

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.

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**	

	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**	

		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	

	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

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

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;**