B

Form Six Mock Examination 2018-2019

DSE BIOLOGY PAPER 1

SECTION B: Question-Answer Book B

This paper must be answered in English

INSTRUCTIONS FOR SECTION B

(1) Write your name, class and class number in the space provided on this page.

(2) Refer to the general instructions on the cover of the Question Book for Section A.

(3) Answer **ALL** questions.

(4) Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.

(5) Supplementary answer sheets will be provided on request. Write your name, class, class number and question number on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.

(6) Present your answers in paragraphs whenever appropriate.

(7) The diagrams in this section are **NOT** necessarily drawn to scale.

Candidate number	

Question No.	Marks
1	/ 4
2	/4
3	/ 6
4	/ 8
5	/ 12
6	/ 3
7	/ 7
8	/ 11
9	/5
10	/13
11	/11
Total:	/ 84

SECTION B

Answer **ALL** questions. Put your answers in the spaces provided.

1. For each of the structures listed in Column 1, select from Column 2 one biological process that matches it. Put the appropriate letter in the space provided. (4 marks)

Column 1		*Column 2*
Outer mitochondrial membrane	_____	A. Formation of NADPH
Matrix	_____	B. Formation of lactic acid
Cytoplasm	_____	C. Oxidation of pyruvate
Inner mitochondrial membrane	_____	D. Oxidative phosphorylation
		E. Active uptake of pyruvate

Answer: E, C, B, D

2. People with lactose intolerance failed to produce sufficient lactase in small intestine.

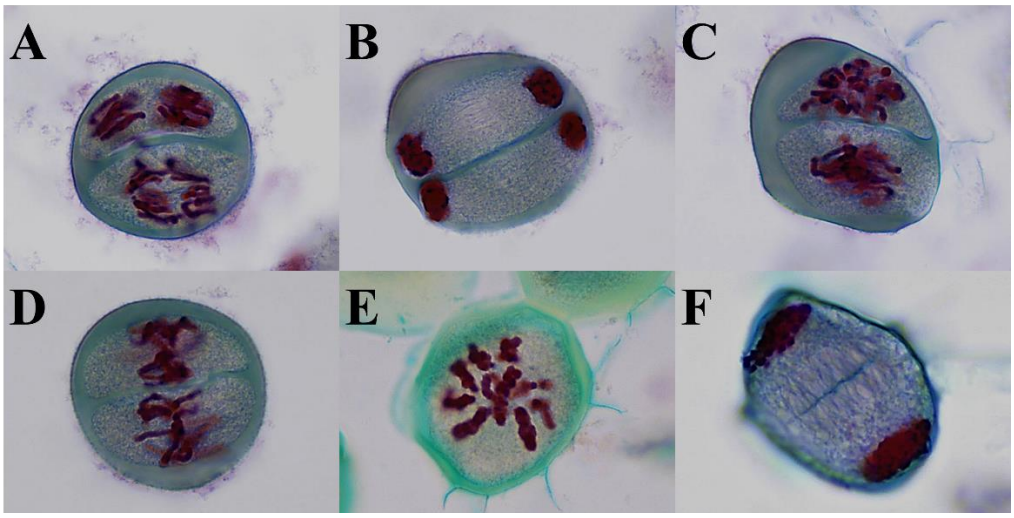
   (a) Use a word equation to show how lactose is broken down in small intestine under normal situation. (1 mark)

Lactose (+ water) $\xrightarrow{\text{Lactase}}$ Galactose + Glucose (1)

   (b) Why will a person with lactose intolerance produce watery faeces if he consumes meals rich in lactose? (3 marks)

Patients with lactose intolerance failed to break down lactose effectively. (1)
This decreases the water potential of chyle in small intestine and thus the water potential gradient between blood and chyle becomes less steep. (1)
Less water is absorbed from the chyle to blood in small intestine. (1)

3. Each pollen mother cell undergoes meiotic cell division to form pollen grains. The photomicrographs below show some of the stages (A to F) of the division:



(a) Arrange the above stages in the correct order. (1 mark)

E→F→C→D→A→B (deduct 1 mark per mistake)

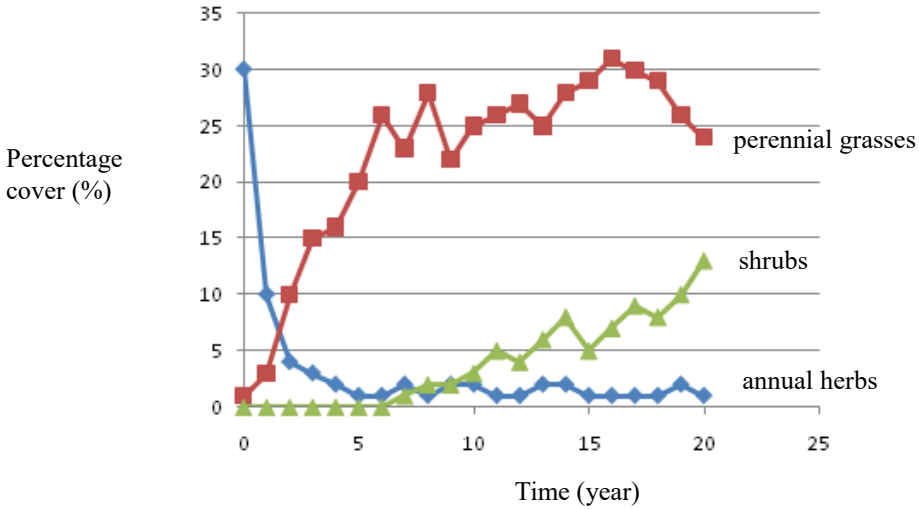
(b) Name stage D. Give ***two*** evidences to support your answer. (3 marks)

Metaphase II (1)
The chromosomes are aligned in the middle of the cells. (1)
There are already two daughter cells inside the pollen grain. (1)

(c) Are the two daughter cells in stage C are genetically identical? Explain your answer. (2 marks)

They are genetically different/not identical (1) because
One of the following:
Crossing over between non-sister chromatids / segments of chromatids between homologous chromosome pair, leads to exchange of genetic materials between homologous chromosomes. (1)
Members of homologous chromosomes are separated into daughter cells in anaphase I, the homologous chromosomes are not identical /may carries different alleles, therefore daughter cells are not genetically identical (1)

4. A group of scientists have studied the succession of a forest since it was cleared by wildfire twenty years ago. The fire removed all aerial parts of plants. The data they collected are shown in the graph below:



(a) Suggest two reasons why succession in this case is usually a quicker process than primary succession? (2 marks)

Soil already exists/ more nutrients already present in soil compared with the barren rock in primary succession (1)
Seeds and underground vegetative parts of various plant species already exist in soil which can grow and develop into new plants once the conditions become favourable. (1)

(b) (i) Complete the following flow chart to show the pattern of succession in the burnt area based on the graph. (1 mark)

Annual herbs → perennial grasses → shrubs (1)

(ii) Explain the pattern of succession in the burnt area. (3 marks)

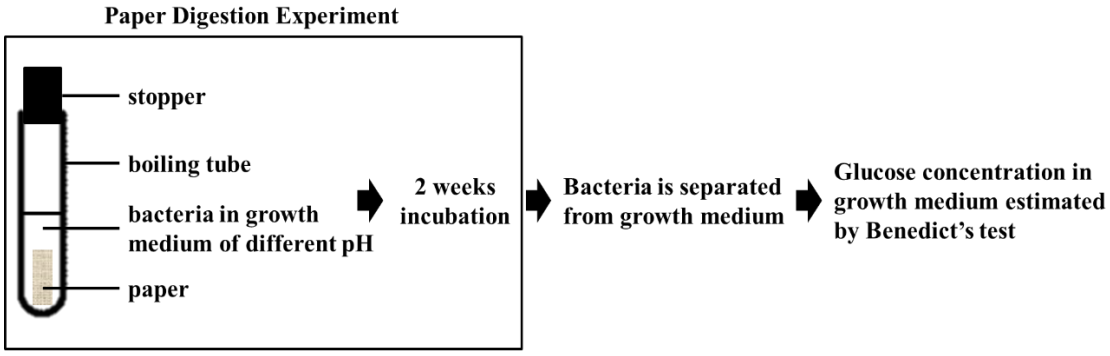
Annual herbs are quickly growing/reproduce quickly/ produce large number of seeds, (when not shaded by tall tree,) their seeds or underground vegetative parts form new plants quickly. (1) or
Perennial grass are fast growing with their underground vegetative parts, they survive for years. (1)
(Attract insects and small animals)
Their dead bodies increase soil nutrients content after decomposition,
Higher soil nutrient content support shrubs growth (1)
Shrubs become dominant as they shade the sunlight from the low-lying species. (1)

(c) The group of scientists estimated that the burnt area will need several decades to reach the climax community which will be more stable than the intermediate community shown above. Explain why a climax community would be a more stable one. (2 marks)

Higher species diversity (1)
The removal/extinction/drop or rise in population size of a certain species will not produce a great

disturbance to its predator/prey (1) or
Reduced reliance on a single organisms for food.

5. Paper is mostly composed of cellulose. Cellulose cannot be digested by most animals as they lack the enzyme cellulase. Some soil bacteria contain the enzyme and play important role in the carbon cycle. A cellulose-producing bacteria was isolated and its cellulase activity under different pH was investigated with the procedure shown below:



(a) What is the relationship between the glucose concentration in growth medium and cellulase activity? (1 mark)

A higher glucose concentration in growth medium indicates a higher cellulase activity. (1)
The following answers are not accepted: positive relationship, (directly) proportional

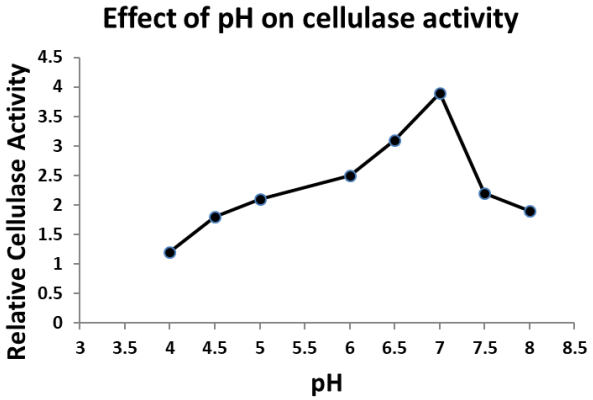
(b) Suggest ***one*** controlled variables for the paper digestion experiment. (1 mark)

Any reasonable answer such as:
The temperature for the experiment. (1)
The initial amount of bacteria in the growth medium (1)
The volume of growth medium added to digest the paper. (1)
Types/thickness/sizes of paper being digested. (1)

(c) You are provided with glucose solutions of different concentrations, suggest how the glucose concentration in the growth medium can be estimated from the glucose solutions given. (3 marks)

A standard curve can be prepared by weighing the brick-red precipitate formed by glucose solution of different concentrations. (1)
By weighing the brick-red precipitate formed in the growth medium. (1)
We can find the corresponding glucose concentration by comparing the result to the standard curve. (1)

(d) The bacterial cellulase activity was measured and recorded below:



(i) What is the optimal pH of this bacterial cellulase? (1 mark)

7 (1)

(ii) Explain the effect of pH on cellulase activity when the pH of the growth medium is higher than the optimal pH. (3 marks)

When the pH is higher than the optimal pH, the cellulase activity drops (when the pH increases). (1)
When pH increases, *more and more cellulase are being denatured or
as the shape of the cellulase active site is being altered. (1)
The active sites becomes *less and less able to fit the substrate/ to form enzyme-substrate complex. / *more and more cellulose molecules can't bind with cellulase (1)
*this concept is marked once, without this concept, 1 mark deducted.

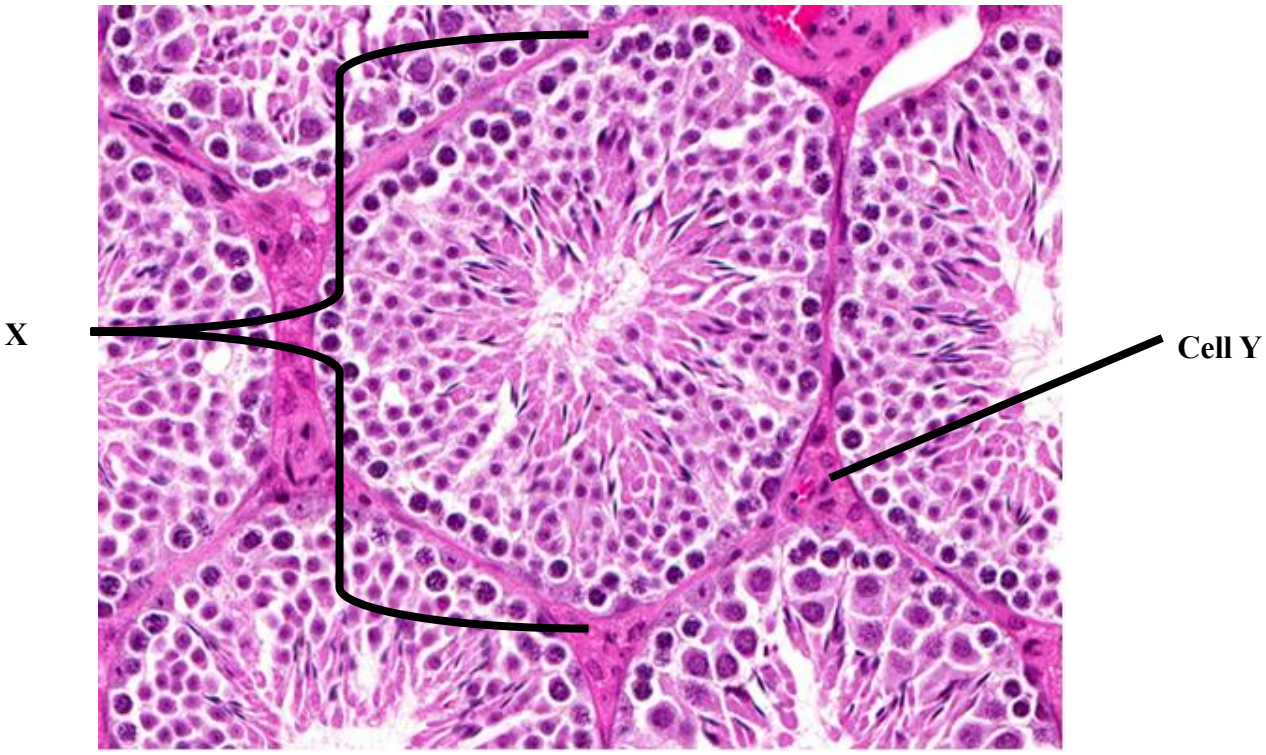
(iii) In paper making industry, degradation of cellulose often involves chemicals such as strong alkali. Based on the experimental result, suggest ***one*** advantage of using cellulase for cellulose degradation over chemicals. (2 marks)

Cellulose degradation can be performed at neutral pH (1) which causes less harm to the environment. (1)

(e) In this investigation, bacteria was cultured in growth medium of different pH. Suggest ***one*** assumption behind this treatment. (1 mark)

The pH of the bacterial culture has negligible effect on the growth of bacteria/health of bacteria/production rate of catalase/glucose absorption rate. (1)

6. The following photomicrograph shows a transverse section of human testis.



(a) Name structure X. (1 mark)

Seminiferous tubule (1)

(b) Is cell Y a diploid or haploid cell? (1 mark)

Diploid (1)

(c) Give ***one*** function of cell Y. (1 mark)

To produce male sex hormone / testosterone (1)

7. Rheumatoid arthritis is a disease of the joints in the human body. It is an auto-immune disease where the immune system treats some self antigens as non-self. The symptoms of rheumatoid arthritis include inflammation of the joints, stiffness and loss of function.

(a) What are antigens? (1 mark)

Protein / glycoprotein / polysaccharide / substances (present on cell membrane) which stimulates /trigger immune response / production of antibodies (1)

(b) Explain why the inflamed joints show symptoms as redness, swelling and pain. (3 marks)

- arterioles of the tissue with inflammatory response dilate, increasing blood flow to the tissue and makes it red (1)
- permeability of capillary wall increases, increasing the formation of tissue fluid and its accumulation, and leads to swelling (1)
- more tissue fluid presses against nerve endings, stimulating the pain receptors and gives the pain sensation (1)

The inflammation is triggered by a chemical known as TNF-α, produced by the patients' own cells. One approach to the treatment of rheumatoid arthritis is by the use of monoclonal antibody against TNF-α.

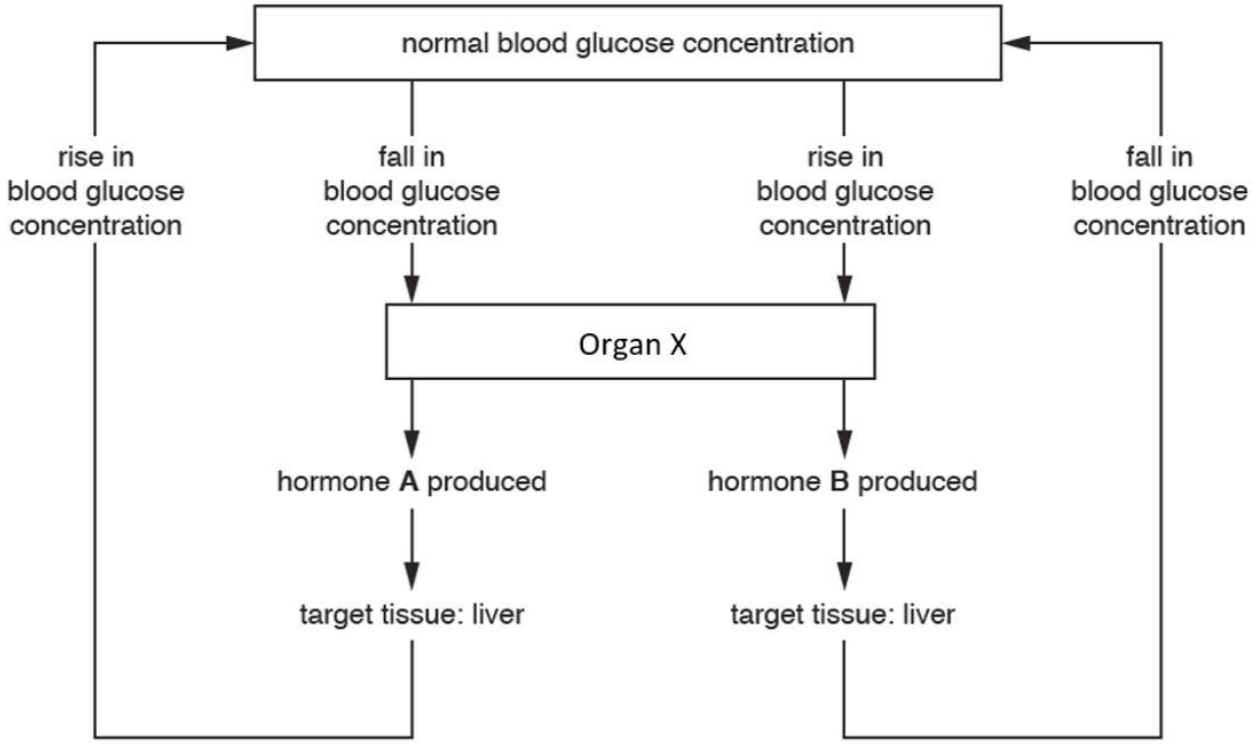
(c) Name the biomolecule that make up the antibody. (1 mark)

Protein / polypeptide/ amino acid

(d) Suggest the mechanism of how antibodies act against TNF-α to reduce the symptoms of rheumatoid arthritis. (2 marks)

Antibodies bind to / inactivate / destroy TNF-α (1)
Inflammation cannot be triggered (1)
Note that TNF-α is not a cell, you can't lyse it.

8. The flow chart below outlines how two hormones, A and B, are involved in the regulation of blood glucose concentration.



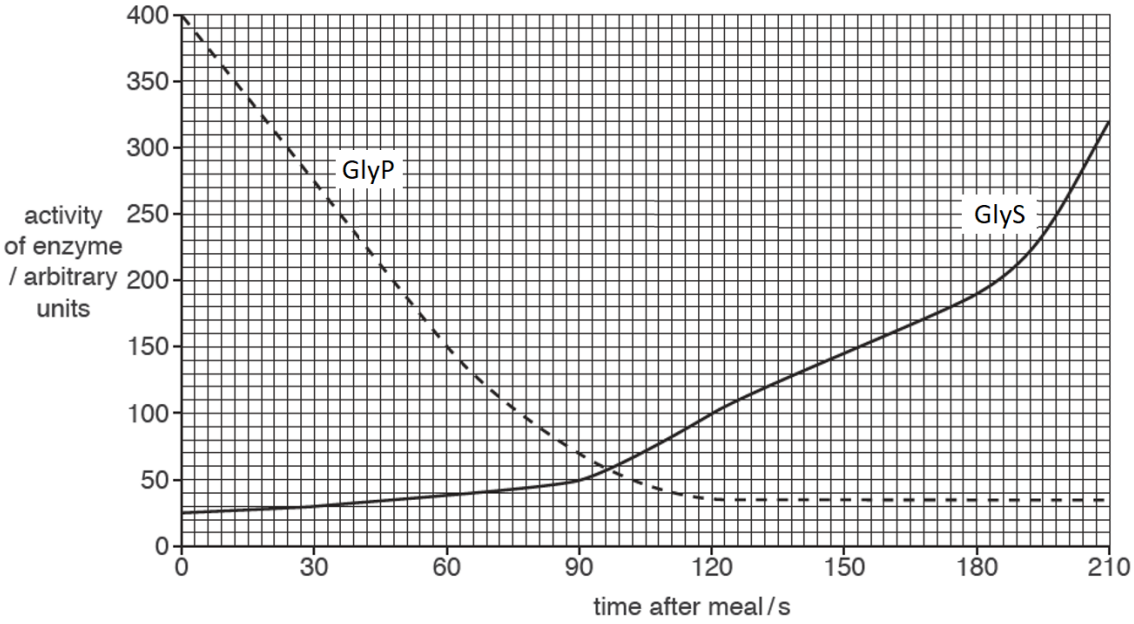
(a) Name hormone B. (1 mark)

Insulin

(b) Apart from acting on the liver, state how hormone B could help decrease blood glucose level. (1 mark)

stimulate body cells to take up more glucose / breakdown glucose by respiration

Two enzymes in liver cells, GlyP and GlyS, are involved in blood glucose regulation by controlling the glycogen metabolism in liver cells. The graph below shows the activity of these two enzymes after consumption of a glucose meal.



(c) With reference to the flow chart and the graph above, deduce the roles of GlyP and GlyS in glycogen metabolism in liver after the glucose meal. (6 marks)

Absorption of glucose into blood after the meal leads to increase in blood glucose level (1)
Organ X produces less hormone A and more hormone B (1)
More hormone B stimulates liver to convert excess glucose to glycogen (1)
Increasing activity of GlyS indicates that it is the enzyme involved in glycogen synthesis(1)
Less hormone A decreases rate of breakdown of glycogen to glucose by liver (1)
Decreasing activity of GlyP indicates that it is the enzyme responsible for breaking down glycogen (1)

(d) Other than endocrine gland, organ X also functions as an exocrine gland. State how the exocrine function of organ X would lead to an increase in blood glucose level after a starchy meal.

(3 marks)

Secrete amylase that digests starch to maltose (1) which will be further broken down by other enzymes in small intestine into glucose (1) and be absorbed into blood (1)

9. The Chan family claims that baby Jane, given to them at U hospital, does not belong to them and that baby Sara, who was presented to the Wong family, really belongs to them. They insist that two babies were swapped accidentally. Blood group determinations show the following results:

Mrs Chan, AB and Mr. Chan, O;
Mrs Wong, A and Mr. Wong O;
Baby Jane, A ; Baby Sara. O.

Suppose you were the genetic counsellor of U hospital, explain to the Chan family who their baby is.
(No mark will be awarded for genetic diagram.)

(5 marks)

Baby Jane belongs to the Chan family. (1)
Human blood groups are determined by a single gene with three alleles, I^A, I^B and i. Alleles I^A and I^B are co-dominant, while allele i is recessive, where I^A represents the allele for making antigen A, I^B represents the allele for making antigen B and i represents the recessive allele for not making antigen A or B on red blood cells surface. (1)
Mrs Chan's genotype is I^AI^B (1),
Mr Chan's genotype is ii (1)
Their offspring either receive I^A and i to have blood group A or I^B and i to have blood group B OR not possible to receive two i to have blood group O (1)

10. The rock pocket mouse is found in rocky outcrops in the Sonoran desert of the southwestern United States. They are nocturnal. They eat mainly plant seeds and makes small burrows in soil under rocks to avoid being preyed on by owls.

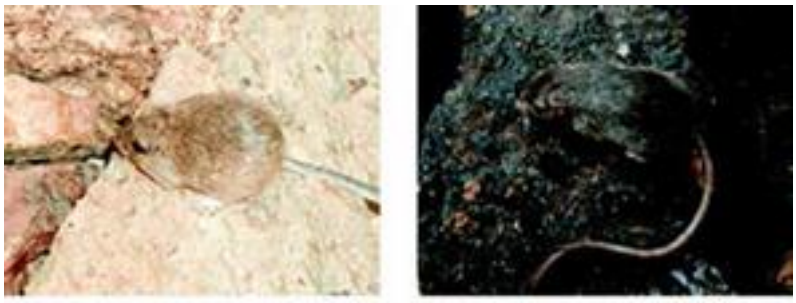
(a) Based on the above information, construct a possible food chain in the Sonoran desert. (1 mark)

Plant seeds → rock pocket mouse → owl (1)

(b) With reference to ***one*** particular abiotic factor in the desert, state the significance of the nocturnal behavior of rock pocket mice? (1 mark)

The rock pocket mouse is nocturnal to avoid the high temperature of desert during the daytime. (1)

Most rock pocket mouse populations have light coloured fur consistent with the colour of the desert rocks on which they live. However, darker coloured rock pocket mice are found living on black rock formations.



Light and dark rock pocket mice on light granite and dark basalt rocks (Photo: Hopi E. Hoekstra)

The dark coat colour of the rock pocket mouse is caused by five mutations occurred in the MC1R gene which codes for a signal protein embedded in the membrane of a cell type specialized for pigment production. The base sequences of DNA segments involved in the mutations are shown below:

The number in italic form shows the order of amino acid on the protein molecule.

Base sequence on the template strand of the wide-type MC1R gene (Light coat-colour phenotype)
015 *022* TTGAGGTGGGCGTGTCCGCAACCA *105* *112* CGGGACCGGTGGGCCCACTGACAC *154* *161* TCATAACACTGTGACGGGGCCCGA *209* *212* GTGTACGAACGT *230* *237* GAACAGGTGGTTCCAAAGGCTGAG

Base sequence on the template strand of the mutant MC1R gene (Dark coat-colour phenotype)
015 *022* TTGAGGTGGACGTGTCCGCAACCA *105* *112* CGGGACCGGTGGACCCACTGACAC *154* *161* TCATAACACTGTGACGGGACCCGA *209* *212* GTGTACGAGCGT *230* *237* GAACAGGTGGTGCCAAAGGCTGAG

(c) There is one mutation in each of the above segments as circled. State the type of point mutation shown in the MC1R gene. (1 mark)

Substitution (1)

(d) (i) Write down the base sequence on the messenger RNA transcribed from the following segment of DNA. (1 mark)

DNA: TTGAGGTGG
mRNA: AACUCCACC or CCACCUCAA (1)

(ii) Based on the codon table shown below, find out the 18th amino acid in the protein coded by the wide-type MC1R gene and mutant MC1R gene respectively. (1 mark)

Wide-type : Arg
Mutant : Cys (1)

Codons Found in Messenger RNA

First Base	Second Base U	Second Base C	Second Base A	Second Base G	Third Base
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	Stop	Stop	A
	Leu	Ser	Stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

(iii) Explain why the changes in base sequence of the MC1R gene would affect the structure and function of the membrane signal protein coded. (3 marks)

Changes in DNA base sequence caused changes in the codons on the mRNA. (1)
Change the sequence of amino acids / primary structure of the protein (1)
These can change the secondary / tertiary structure / three-dimensional conformation of the protein (1)
The function of a protein depends on its structure, since four amino acids are changed on the MC1R protein due to mutations in the MC1R gene, the conformation of the protein may be changed a lot so that it will not function properly.

(e) It is commonly thought that "***all mutations are bad***". Use the example of rock pocket mice to explain why this is ***not true***. (4 marks)

Mutations may result in new traits. The selective advantage provided by a trait depends on the environment. (1)
For example, on a light substrate, individuals with dark-colored coats would be at a disadvantage because they would stand out more than individuals with light-colored coats, making them easier for predators to spot. (1)
However, in the dark lava flow habitat, those same dark-colored individuals would have a selective advantage because they would be better camouflaged than light-colored individuals. (1)
So the statement that "all mutations are bad" is incorrect, because there are different selective pressures on the traits produced by mutations depending on the habitat.
There are also silent mutations that do not change the resulting protein; these are neutral, neither good nor bad, e.g. the 211th amino acid of the MC1R protein remains unchanged even after the mutation (1)

(f) The mutations result in the dark coat colour of rock pocket mouse was discovered by a researcher called Nachman. However before his work, biologists have worked out the genetic and biochemical processes that control coat colour for the common laboratory mouse which is evolutionary closely related to rock pocket mouse.

What does this tell us about the nature of science? (1 mark)

Scientists build on the work of other scientists / results of previous experiments. OR
Finding out knowledge in science is an ongoing process.

For the following question, candidates are required to present their answer in essay form. Criteria for marking will include relevant content, logical presentation and clarity of expression.

11. In terrestrial flowering plants such as our school's White Jade Lily tree, photosynthesis mainly takes place in the leaf mesophyll cells. Give an account of the processes by which the mesophyll cells obtain the raw materials for photosynthesis. (11 marks)

Content	Description	Mark
Carbon dioxide absorption	- Carbon dioxide in the surroundings diffuse into the intercellular air space of the leaf through stomata - Carbon dioxide dissolves in the water film on the surface of the mesophyll cells and then diffuse into the cells	**1** **1** Max 2
Water absorption from soil	- Soil water usually has a higher water potential than that of the cytoplasm and the cell sap of the root hair cells or root cells. Water therefore moves into the root hair cells by *osmosis. - Water moves across the cortex from cell to cell by *osmosis until it reaches the xylem vessels. (Some water may move inwards along the cell walls, from cell to cell, without entering the cytoplasm or the vacuole).	1 1 Max 2
Formation of transpiration pull	- In the leaves, water evaporates from the surface of mesophyll cells to form water vapour in the air spaces - water vapour diffuses out through the stomata - due to the cohesion between water molecules and adhesion between water molecules and the wall of xylem, water moves up the xylem vessels as a continuous column or without breakage	1 1 1 Max. 2
Upward water transport Water enters mesophyll cells	- Water is drawn up the xylem vessels of the stem by the transpiration pull - Water flows from the xylem vessel to the mesophyll cells by *osmosis	1 1 Max 2

- at least mention once Communication skill: 3 marks

End of section B
End of paper