B

Form Six Mock Examination 2017-2018

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	/ 3
2	/2
3	/ 10
4	/ 7
5	/ 8
6	/ 5
7	/ 8
8	/ 10
9	/ 7
10	/13
11	/11
Total:	**/ 84**

SECTION B

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

1. For each of the structures in a plant cell listed in Column I, select from Column II one phrase that correctly describes it. Put the letter in the space provided. (3 marks)

Column I		***Column II***
Cell membrane	C	A. Helps in the synthesis and transport of lipids
Vacuole	E	B. Helps in the synthesis and transport of proteins
Smooth endoplasmic reticulum	A	C. Control the movement of substances into or out of a cell
		D. Provide a site for chemical reactions to take place
		E. Support the cell

2. The table below shows how a bird called the bluethroat (*Luscinia svecica)* is classified by biologists.

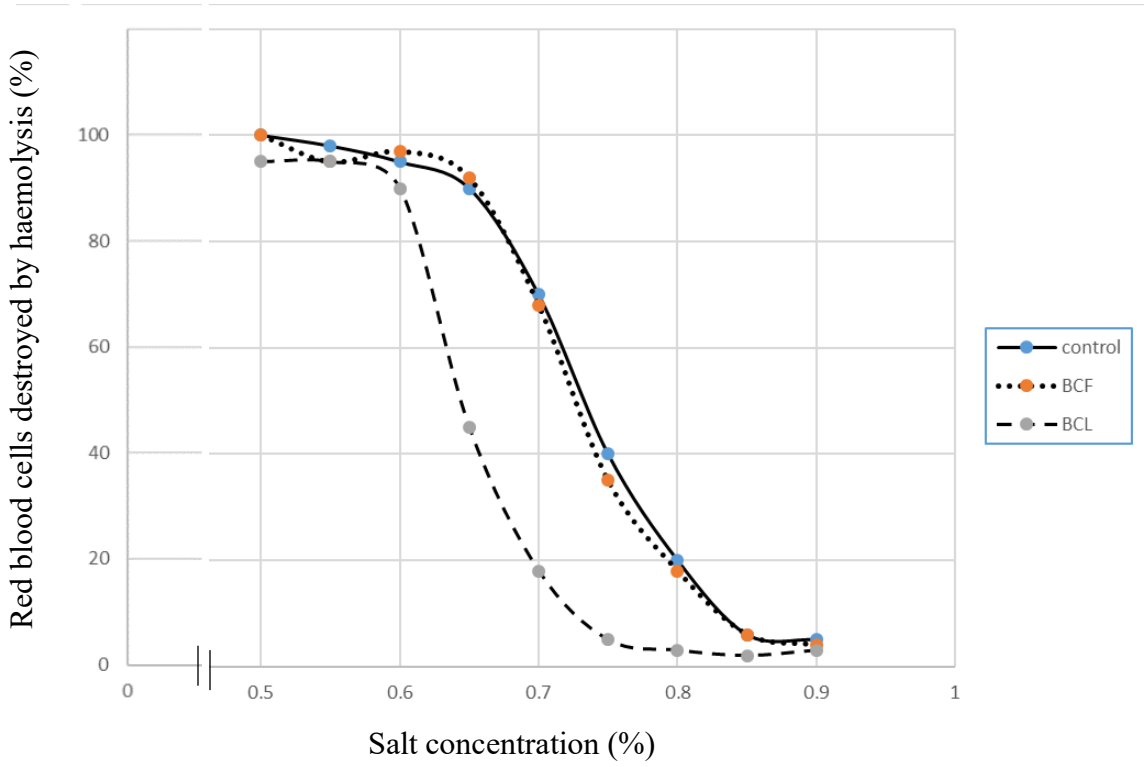
Taxonomic group	***Name***
Domain	Eukaryota
Kingdom	Animalia
Phylum	Chordata
Class	Aves
Order	Passeriformes
Family	Muscicapidae
Genus	*Luscinia*
Species	*svecica*

Complete the table by filling in the blanks with the correct terms. (2 marks)

3, An investigation was carried out to study whether antioxidants in blackcurrant leaf extract (BCL) and blackcurrant fruit extract (BCF) can protect the pig's red blood cells from haemolysis.

Pig's red blood cells, upon removing from plasma, were divided into three groups. The experimental groups were suspended in an isotonic solution containing the respective plant extracts while the control group was suspended in an isotonic solution instead. All groups of cell were kept at 37°C for 1 hour. After that, the three groups of cell were removed from their solutions by centrifugation and were placed in salt solution from 0.5% to 0.9% separately. The percentage of cells destroyed by bursting (haemolysis) was recorded and the results were shown in the graph below.

Percentage of haemolysis of cells modified with BCL and BCF extract at salt solution of different concentration



(a) Explain, in terms of water potential, why some red blood cells burst when placed in 0.7% salt solution. (3 marks)

The water potential of the cytoplasm of the cells is lower than that of the 0.7% salt solution (1).
Water enters the cells by osmosis (1)
The cell membrane cannot withstand the pressure build up due to continuous water entry (1), thus burst.

(b) Suggest why some red blood cells did not burst in 0.7 % salt solution. (1 mark)

Some red blood cells have a water potential which is higher than those burst. (1m)

(c) Based on the information shown in the graph, can the blackcurrant leaf extract (BCL) and the blackcurrant fruit extract (BCF) protect the red blood cells from haemolysis? Give an evidence to support your answer. (3 marks)

BCL can give some protection but BCF can't (1)

Compare with those of the control group, a lower % of cells in BCL were burst in salt solution ranged from 0.85/0.8% to 0.6% (1)

The % of cells in BCF burst in salt solution throughout the whole range of salt solution tested were the same as that of the control (1)

(d) The investigator suggested that the antioxidant in the blackcurrant plant (leaf/fruit) bind to the membrane superficially to modify the membrane without inducing haemolysis.

(i) Based on your knowledge about the membrane structure, to which region of the cell membrane will the antioxidants bind to if the investigator is correct? (1 mark)

Hydrophilic region / phosphate group of the phospholipids (1m)

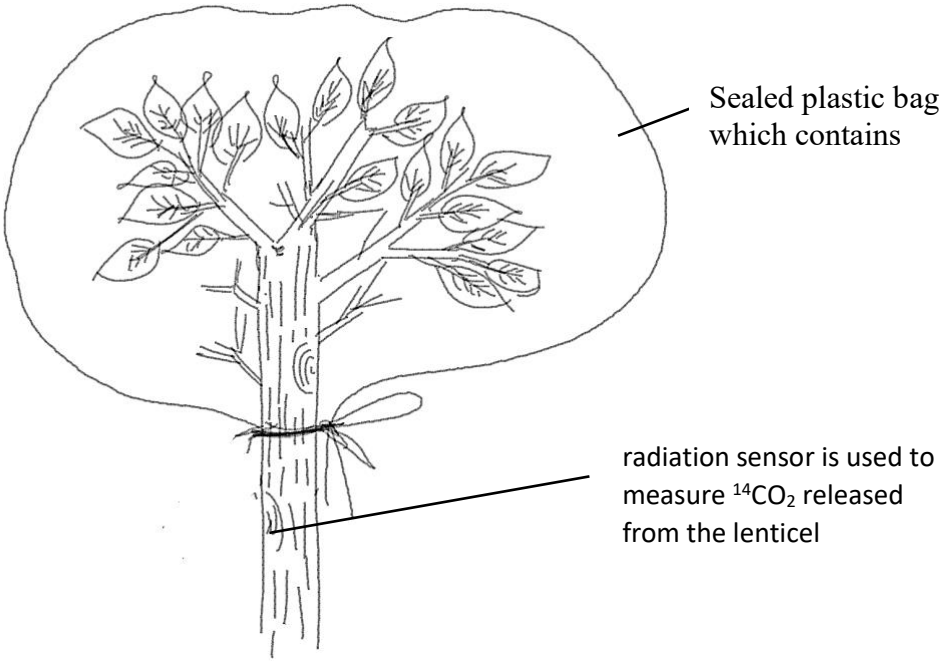
(ii) Give and explain one evidence from the graph that support the suggestion of the investigator. (2 marks)

The % of cells in BCF burst in salt solution throughout the whole range of salt concentrtion tested were the same as / not higher than that of the control (1)

If the substances penetrate/embed deeply into the membrane/ hydrophobic region, this will weaken the interaction between its components.

If the structure of the membrane is disturbed, this will facilitate the entry of water into the cells, the cell will burst at a lower concentration of salt solution / a higher percentage of cells than control will burst at the same salt concentration. (1)

4. Scientists measured translocation in the phloem of trees. They used carbon dioxide labelled with radioactive ^{14}C. They put a large, clear plastic bag over the leaves and branches of each tree and added $^{14}CO_2$ as the diagram shown below. The main trunk of the trees was not in the plastic bag. At regular intervals after adding the $^{14}CO_2$ to the bag, the scientists measured the amount of $^{14}CO_2$ released from lenticels from the main trunk of the tree using sensor.



(a) Describe the pathway through which the $^{14}CO_2$ in the plastic bag entered mesophyll cells. (2 marks)

Carbon dioxide in the plastic bag diffuses into the air space through stoma. (1)
It dissolves in the water film on the surface of mesophyll cells and then diffuses into the cells and the neighboring cells. (1)

(b) Briefly describe the cellular processes in which $^{14}CO_2$ entered mesophyll cells can be utilized and finally be detected from the tree truck. (5 marks)

Mesophyll cells carries out photosynthesis and produce glucose using radioactive carbon. (1)
The glucose produced is converted into sucrose and is translocated from the top to the bottom of the trunk via phloem. (1)
Cells from the lower part of the trunk takes up sucrose and converts it back to glucose. (1)
Glucose was used in respiration to release energy and carbon dioxide is produced as the by- product. (1)
Radioactive carbon dioxide left through the lenticel via gaseous exchange. (1)

5. In the Arctic, snowy owls are predators of lemmings. The lemmings eat Arctic plants.

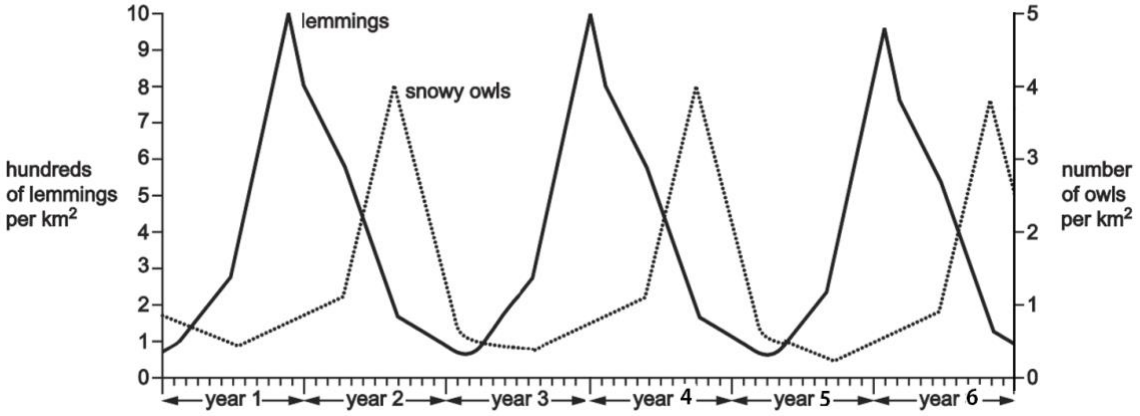
(a) Draw the food chain for this Arctic ecosystem. (1 mark)

Plant →lemmings → snowy owl (1)

(b) Suggest a method how researchers can identify food sources of snowy owls and state the limitation of the method mentioned. (2 marks)

Dissect the owl and find the undigested food inside its stomach. (1)
Lots of owl will be killed for research and affect the interaction between organism in the habitat. (1)

(c) The graph below shows changes in the populations of snowy owls and lemmings over a six-year period.



Describe and explain the periodic fluctuation of population sizes of snowy owls and lemmings in the graph. (4 marks)

when the predation pressure/ owl population is low, the lemming population can increase rapidly. (1)
a greater population of lemmings can support rapid growth of the owl population (1)/ reproduction of the owls, thus the owl population increases subsequently.
Lemming population will drop due to increased predation (1)
When the food supply (prey) becomes less, owl population drops subsequently. (1) and the cycle repeats. (1) max. 4

(d) A student said, “a simple food web in the ecosystem is less stable in environmental fluctuation than a complex food web.” Using the food chain in (a) as an example, justify why the student’s claim is correct. (2 marks)

When the lemming population decrease due to extinction, this will lead to the total extinction of the owls immediately and the uncontrollable increase of plants. (1)/ However if the food chain is more complex, owl can still rely on other lower consumers but not extinction (1)
which can stablize the number of organisms in each trophic level with reasonable number with less significant effect by environmental fluctuation. (1)

6. The cold receptor protein is encoded by a gene called T. If gene T is mutated it is possible for the cold receptor to become less sensitive to coldness. Some of the variations in the triplet codes on the coding strand in an important region in gene T are shown below. A mRNA codon table is given for assistance.

Original sequence: -CTT-CTA-TGG-CAC-TAC-	
Variant 1:	-CTT-CTA-TGG-CAT-TAC-
Variant 2:	-CTT-CTT-TGA-CAC-TAC-
Variant 3:	-CTT-CTT-ATG-ACA-CTA-

Amino acids	**mRNA codons**
Leucine	CUA, CUU, CUC
Tryptophan	UGG
Histidine	CAU, CAC
Tyrosine	UAU, UAC
Threonine	ACA, ACU
Stop codon	UGA, UAA
Methionine	AUG

(a) Identify the variant(s) with substitution mutation. (1 mark)

Variant 1, 2 and 3.

(b) With respect to processes in protein synthesis, explain why variant 2 should cause the most drastic change in the function of cold receptor. (4 marks)

Gene mutation leads to the appearance of a stop codon in the middle of the gene T DNA
Translation of gene T mRNA will stop at the stop codon
The protein encoded will become shortened/most drastic change in the amino acid sequence of the protein
The protein 3D structure/conformation should be changed a lot

7. In 1920s, Otto Meyerhof done an experiment: If an isolated frog leg is stimulated electrically, the leg muscles can contract several times but soon became fatigue. During and after the stimulation, lactic acid level in the leg muscle cells increases.

(a) Suggest one reason to explain why the cells in the isolated leg muscle soon became deoxygenated before the experiment. (1 mark)

The cells no longer receive continuous oxygen supply from blood/heart
while oxygen is consumed continuously via respiration
or
The diffusion distance between the atmosphere and the cells is too great so that the oxygen uptake rate is too low,
while oxygen is consumed continuously via respiration

(b) Describe how stimulation of leg muscles leads to lactic acid production. (3 marks)

(The stimulation leads to muscle contraction such that) muscle cells undergo anaerobic respiration/lactic acid fermentation (in the absence of oxygen)
To release (additional amount of) energy/produce (more) ATP to support the muscle contraction
Glucose is broken down into pyruvate(3-C compound), then converted into lactic acid (with the use of ATP and NADH)

(c) From the experiment Otto Meyerhof believed lactic acid accumulation leads to muscle fatigue and can be used to explain why people feel prolonged muscle fatigue after exercises. However in 1970s, George Brook found out that when different carbohydrates (i.e. lactic acid, glucose, glycogen and starch) are injected into a living rat, lactic acid is the fastest carbohydrate that can be broken down completely in the presence of oxygen.

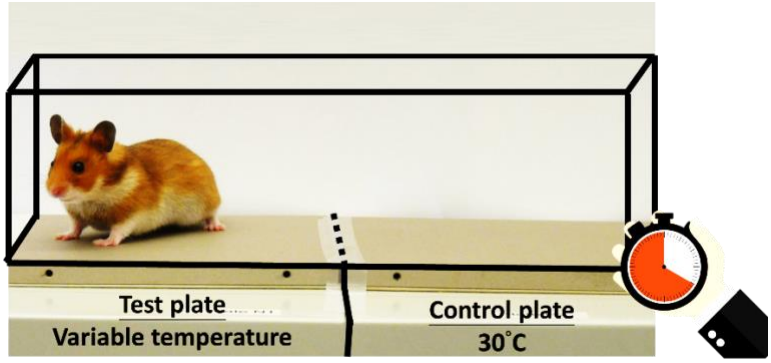
(i) Describe how lactic acid is broken down completely in the liver. (2 marks)

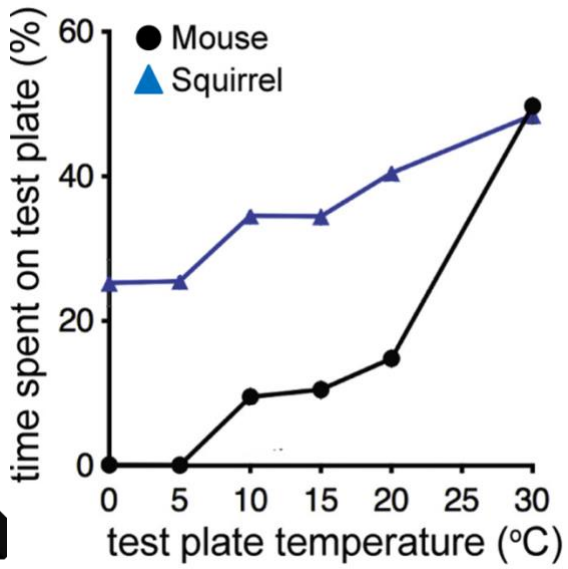
Lactic acid is first converted into pyruvate
(In the presence of oxygen), lactic acid enters Krebs cycle and is oxidized to carbon dioxide and water

(ii) The finding from George Brook eventually helps to disprove the Meyerhof hypothesis that lactic acid accumulation is not the main reason for muscle fatigue. What nature of science can be demonstrated by George Brook in order to reject the Meyerhof hypothesis? Elaborate your answer. (2 marks)

Scientific knowledge is evidence based
as George Brook performed experiments to show lactic acid accumulation is unlikely due to its fast decomposition rate.
or
Scientists are skeptical to scientific theory.
as George Brook was not just satisfied by the simple explanation by Meyerhof and questioned his hypothesis
Reasonable answers are accepted

8. An experiment was performed to investigate the cold sensitivity of animals. Each time two metal plates are provided to an animal, one in 30˚C (control plate) while another in variable temperature (test plate). The time animal spent on each metal plate is then measured. Below show the experimental setup (left) and a graph showing the results for mouse and squirrel (right).





(a) With reference to the graph, compare the cold sensitivity between mouse and squirrel. (2 marks)

The cold sensitivity of the squirrel is less than the mouse.
The average time spent on test plate by squirrel is greater than that of mouse (when plate temperature is lower than 30˚C)

(b) Hibernation is a behavior in which animals lower their metabolic rate when food availability is low (i.e. winter). During hibernation, animals do not wake up. One of the crucial requirements for successful hibernation is that animals should not be over sensitive to certain external stimulus.

(i) State which animal, mouse or squirrel, should have a higher chance to hibernate successfully? (1 mark)

Squirrel

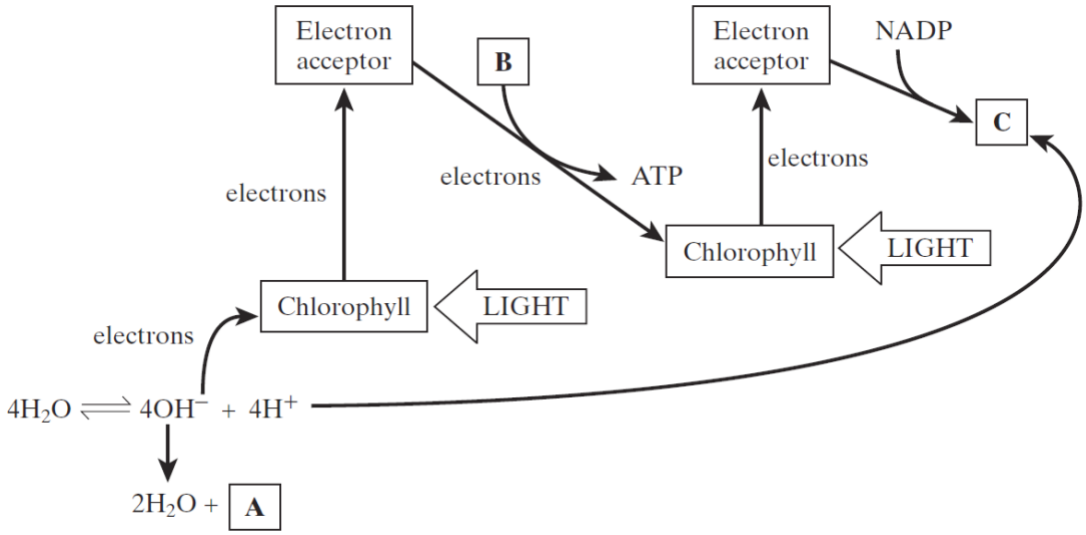
(ii) Explain how the hibernation behavior enables animals to survive in stressful condition like winter. (3 marks)

Due to low food availability, energy intake is expected to be low in such condition
Hibernation enables animals to reduce its energy consumption
To maintain basal metabolism/to meet the basic energy requirement in such condition

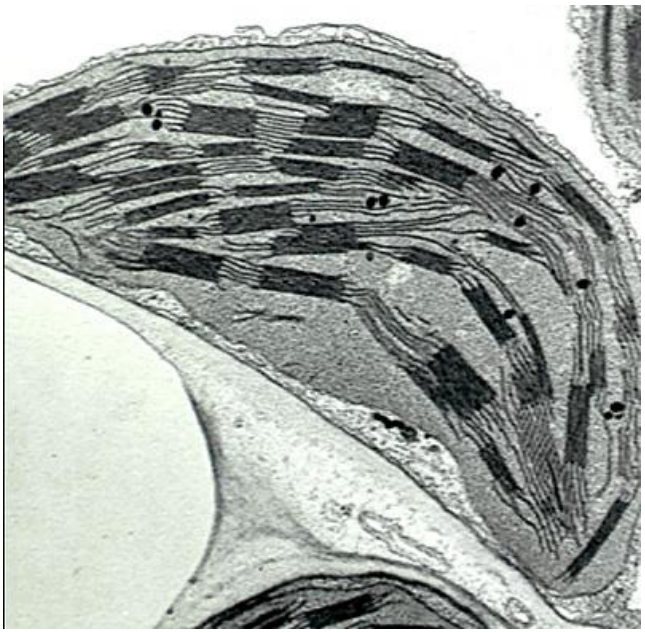
(c) Both squirrels and their ancestors can be found in polar region where used to be in moderate temperature and good food supply 20000 years ago. According to the theory of natural selection and the above information, propose how squirrel might gain the ability to survive in polar region even in present days. (4 marks)

Within the squirrel population in polar region, there are individual variations in cold tolerance
Due to the food supply/weather drop in polar region, a selection pressure is posed on the squirrel ability to survive in cold/starving conditions.
Those individual with better cold tolerance can hibernate successfully so as to better survive and reproduce in the stressful condition (than those who cannot)
They also pass the ability to tolerate coldness to their offspring (and thus the cold-tolerating squirrel becomes the dominant population in present day polar region)

9. The diagram shows the light- dependent reactions of photosynthesis.



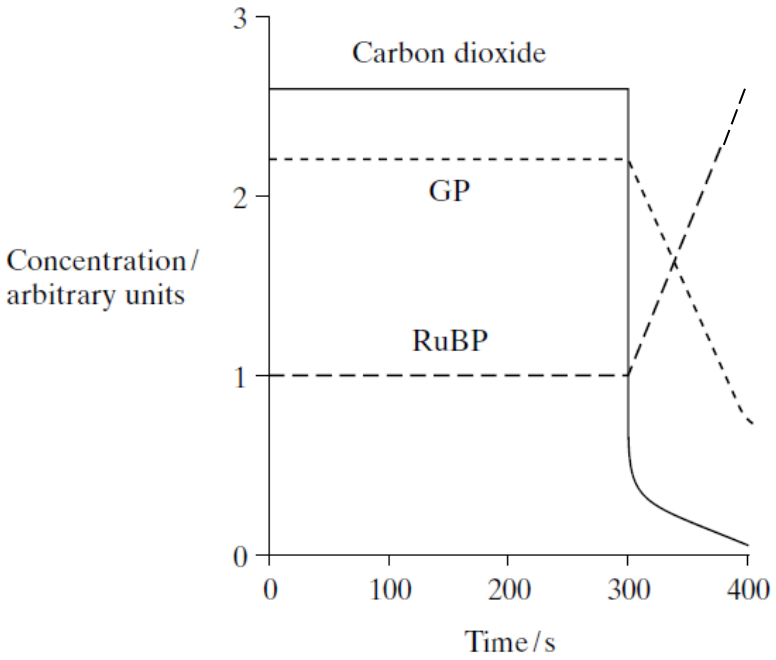
(a) Name and label the part of chloroplast carried out light dependent stage in the electromicrograph below. (1 mark)



(b) What is the significance of substrate B and product C to the whole photosynthetic process? (2 marks)

B: convert to ATP which provides energy to drive light- independent reactions/ for the regeneration of carbon dioxide acceptor. (1)
C: provide reducing power for the reduction of 3C compound to form glucose (1)

(c) in an investigation, single- celled algae were kept in bright light and were supplied with carbon dioxide containing radioactive carbon atom. After 300 seconds, the carbon dioxide supply was turned off. The graph shows how the concentrations of carbon dioxide, glycerate 3- phosphate (GP) and ribulose bisphosphate (RuBP) changed.



(i) What is the biological significance of higher concentration of GP than RuBP in photosynthesis? (2 marks)

Excess GP can be reserved for glucose formation (1)
and to maintain the constant level of RuBP in chloroplast to maintain Calvin cycle. (1)

(ii) Explain the increase of RuBP level between 300 – 380 seconds. (2 marks)

No carbon dioxide is available to combine with RuBP to form GP. (1)
However, there is constant conversion of GP to (TP then to) RuBP. (1)

10. A scientist investigated the role of light, sucrose and fungi in seed germination rate of *D. fuchsii,* an orchid commonly found in UK.

The scientist hypothesized as follows.

(1) The germination rate increases with the presence of light.
(2) The germination rate increases with the presence of fungi.
(3) The germination rate increases with the presence of sucrose.

120 seeds were collected and sterilized. The seeds were separated into 6 groups and set into germination in separate agar plates under different treatment. Water was supplied in each set up. The table below shows the conditions in each set up and the average change in length of the plumule after 20 days of germination. Given the initial lengths of the plumules were the same.

Treatment	A	B	C	D	E	F
Presence of sucrose	x	√	x	x	√	x
Presence of fungi	√	x	x	√	x	x
Presence of light	x	x	x	√	√	√
Average change of the length of plumule after 20 days (cm)	10	7.8	6.2	4	2.5	1

(a) (i) State the importance of water in seed germination. (1mark)

Activates enzymes to break down the insoluble food reserves into soluble forms by hydrolysis. (1)

(ii) Explain why the scientist sterilized the surface of the seeds and the agar plates before the investigation. (2 marks)

To kill any fungus/bacteria on surface of seeds and the agar plate. (1) So only the added fungus has any effect on the seed germination. (1)

(b) (i) Suggest whether hypothesis 1 is supported with the data given in the table and explain your claim. (3 marks)

When comparing with A and D/ B and E/ C and F (1),
the presence of light inhibits the germination rate instead of increasing as shown by the decrease of average change of the length of plumule after 20 days from set up A to D (1)
Hypothesis 1 is rejected. (1)

(ii) Which factor, the presence of sucrose or fungi, has a more profound effect on the germination rate of *D. fuchsii*? Elaborate your choice with evidence provided by the graph. (2 marks)

Fungi (1)
When comparing A and B/ D and E, the change of length in plumule in A/D is higher than that of B/E with the presence of fungi when other conditions are controlled. (1)

(iii) A student suggested to use the change of dry mass for measuring the seed germination rate instead. He dried the plumule in an oven at 90 °C for 3 days.
Suggest what he should have done during the drying process to be sure that all water had been removed from the plant samples. (1 mark)

Weigh samples at intervals during drying to see if weighing became constant (1)

(c) The scientist investigated further on the ecological relationship of fungi and *D. fuchsii* by isolating the fungal hyphae from *D. fuchsii* and grew under different conditions. The fungal hyphae length was measured after 8 days as an indicator of fungal growth and the results as shown below:

Treatment	G	H	I	J
Presence of *D. fuchsia* seed	√	√	x	x
Presence of light	x	√	x	√
The increase in length of fungal hyphae (mm)	45	30	38	15

(i) Based on the graph above, suggest the possible ecological relationship between the fungi and *D. fuchsii.* (1 mark)

Mutualism

(ii) Fungi usually grow in shady environment. Propose a mechanism on the effect of light on the change in length of fungal hyphae attached on *D. fuchsia* and hence the germination rate of *D. fuchsia*. (3 marks)

The light inhibits the growth of fungal hyphae in *D. fuchsii.* (1)
This decreases the surface area for water absorption of *D. fuchsia/* speed up decomposition of organic matter (1)
Which inhibits the germination rate (1)

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

11. 'Long-term health problems can be brought about if a person takes in a diet that is high in fat, sugar and sodium (salt) but low in dietary fibers.' Give an account of the biological basis for this statement. (11 marks)

(a) Food high in fat: lead to obesity and overweight, obesity due to accumulation of fat in fatty/ adipose tissue,

The following health problems can be resulted:

Max 4

Consequence	Biological basis for health consequence	
(1) cardiovascular and cerebrovascular (stroke) diseases	- excess lipid deposits in arteries may lead to atherosclerosis (1) clog blood vessels in heart and/or brain increase risk of heart attack and/or stroke (1) - hypertension as atherosclerosis in blood vessels offers resistance to blood flow (1), increases stress on heart function / weakening of heart muscle (1)	2 2
(2) high cholesterol in plasma	- diet rich in fat usually constitutes to high cholesterol level which increase the risk of atherosclerosis	1
(3) risk of some cancer disease	- e.g. prostrate cancer in males, breast cancer in females	1
(4) diabetes	- obesity predisposes individual to diabetes, because of decreased sensitivity if insulin receptor to insulin, thus glucose uptake into cell slow down (mark given once only)	1
(5) insufficient rest and oxygen supply at night, tiredness in the day	- breathing problem	1
(6) musculoskeletal problems	- gout and arthritis	1
(7) gall stone	- caused by high cholesterol intake, cholesterol crystallized into stone in gall bladder/ bile duct, hinders fat digestion	1

(b) food with high sugar level Max.2

Consequence	Biological basis for health consequence	
(1) obesity	- excess sugar is converted to lipid and stored as adipose tissue (1), clogs blood vessels, increase risk of heart attack and stroke (1) (mark given once only)	2
(2) dental problems :tooth decay	- acid produced during metabolism of bacteria, dissolves enamel results in dental decay (1) or periodontal gum disease, teeth come off (1)	2
(3) diabetes	- obesity predisposes individual to diabetes, because of decreased sensitivity of insulin receptor to insulin (1)	1

(C) Food with high sodium/salt level Max.2

Consequence	Biological basis for health consequence	
(1) high blood pressure, stress the heart	- excess Na^+ in blood stimulates water absorption / affect water balance(1), blood volume will thus increase (1)	2
(2) stresses the kidney	- kidney work together to expel the excess Na^+	1

(d) Food low in dietary fibres Max.2

Consequence	Biological basis for health consequence	
(1) constipation	Dietary fibre add bulk to the content to stimulates peristalsis in the intestine which move the content forwards (1) If peristalsis is low, gut content stay too long in the intestine, too much water will be absorbed from it(1), too hard increase the difficulty to egest Frequent constipation increase the risk of developing piles (1)	3
(2) higher risk of colorectal cancer	The cause is not fully understood but there is evidence suggesting that diet high in fats and low in dietary fibre could increase the chance of developing colorectal caner	1

END OF PAPER