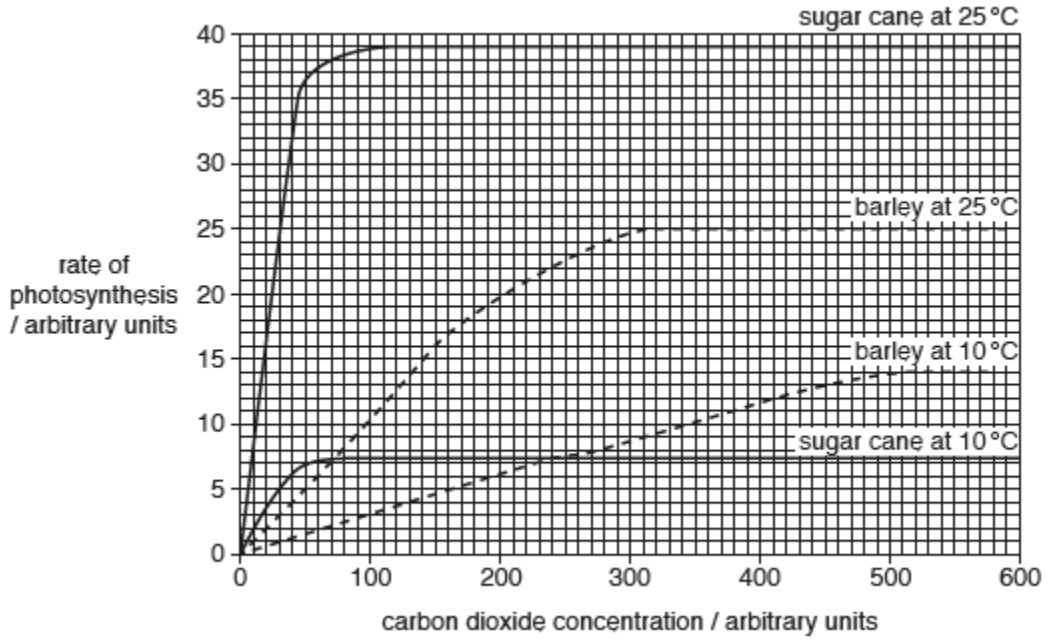
S.6 BIOLOGY (P530/1)
1Hour 30 Minutes

Instructions

*Attempt **all** questions in this paper.*

***Precise and sequential presentation of answers** is required of candidates*

1. The graph in the figure below shows variation of the rate of photosynthesis of barley and sugar cane at two different temperatures, 10℃ and 25℃ with carbon dioxide concentration.



(a) Suggest why in all the four experiments, the rate of photosynthesis remained constant as carbon dioxide concentration increased.

(**1mark**)

Carbon dioxide concentration ceased being a limiting factor;✓ light intensity and temperature are possibly limiting;✓ @ ½ mark

(b) Describe the difference in the rate of photosynthesis between barley and sugar cane at 10℃ . (**3marks**)

Rate of photosynthesis in sugar cane	Rate of photosynthesis in Barley
Higher from 0a.u to 250a.u ✓	***Lower from 0a.u to 250a.u***
Lower from 250a.u to 600a.u ✓	***Higher from 250a.u to 600a.u***
Lower maximum ✓	***Higher maximum***
Maximum attained/becomes constant at a lower carbon dioxide concentration ✓	***Maximum attained/becomes constant at a higher carbon dioxide concentration***

(c) Explain the difference in the rate of photosynthesis between barley and sugar cane at 25℃. (**3marks**)

From 0a. u to 600a.u carbon dioxide concentration, rate of photosynthesis of sugar cane is higher than that of barley;✓ because its carbon dioxide fixing enzyme, PEP carboxylase has a higher optimum temperature than RuBP carboxylase in Barley;✓ thus not denatured;✓ allowing it continue fixing carbon dioxide at even higher temperatures/25℃;✓ its RuBP and RuBP carboxylase enzyme in bundle sheath cells are isolated from air inside the leaf, preventing oxygen reaching these cells;✓ and carbon dioxide from decarboxylation of malate accumulates within the bundle sheath cells;✓ both preventing photorespiration;✓
Rate of photosynthesis of sugar cane increases more rapidly, attaining a maximum at a lower carbon dioxide concentration than barley;✓ because its carbon dioxide fixing enzyme, PEP carboxylase has a higher affinity for carbon dioxide than RuBP carboxylase;✓ thus absorb carbon dioxide efficiently even at lower carbon dioxide concentration;✓ @ ½ mark
Max 3

(d) Explain the following observations.

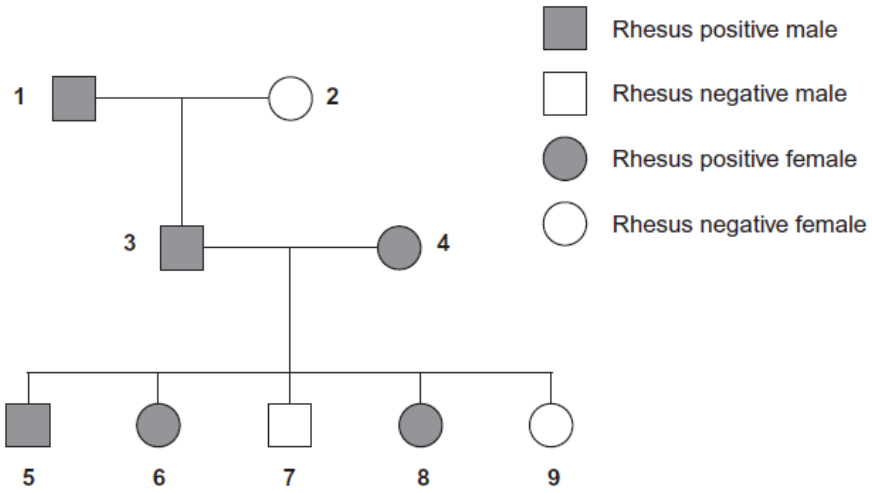
(i) Photorespiration is a wasteful process. (**1½ marks**)

By product, glycolate;✓ on oxidation, fixed carbon dioxide is lost;✓ no ATP is produced;✓ photosynthetic efficiency of plants is reduced;✓ @ ½ mark

(ii) Subjecting plants to alternate flashes of light yield more photosynthetic product than continuous light. (**1½ marks**)

In continuous light, products from the light dependent stage, ATP and NADPH;✓ accumulates;✓ slowing down that process;✓ while with period of darkness/alternate flashes, slower light independent stage use up the products (ATP and NADPH);✓ thus speeding up the overall process;✓ @ ½ mark

2. The diagram below shows the inheritance of the Rhesus blood group in one family. The allele for Rhesus positive, R is dominant to that for Rhesus negative, r.



(a) Explain **one** piece of evidence from the diagram which shows that the;

(i) Allele for Rhesus positive is dominant. (**2marks**)

Two Rhesus positive individuals, 3 and 4 produced only two Rhesus negative children, 7 and 9;✓ because both Rhesus positive individuals carry a recessive allele/are heterozygous;✓

(ii) Gene is not X-linked. (**2marks**)

Daughter 9 would be Rhesus positive/both daughters 8 and 9 of individual 3 and 4, would be Rhesus positive;✓ X chromosome carrying a dominant allele would be passed to daughter 9 by father3;✓
Acc Individual 3 would be Rhesus negative;✓ because Rhesus negative allele on X chromosome from mother would be passed to it;✓

(b) (i) What is the likely consequence of female 2 having subsequent pregnancies with individual 1? (**3marks**)

Subsequent pregnancies with Rhesus positive fetuses;✓ fragments of fetal red blood cells especially around birth, cross to the mother;✓ stimulating production of large quantities of Rhesus antibodies;✓ passed back to fetus via placenta;✓ break down/destroy fetal red blood cells;✓ proving fatal /causing erythroblastosis foetalis (Haemolytic disease of the new born;✓ ***@ ½ mark***

(ii) Explain **one** way in which the above effect can be prevented.

(1½ marks)

Injection of Rhesus antibodies into the mother immediately after birth;✓ destroying any Rhesus positive cells which may have entered her blood;✓ before they stimulate production of the mother's own antibodies;✓ @ 1½ mark

(c) In a human population, 16% of the individuals are Rhesus negative. Using Hardy-Weinberg equation, workout the percentage of individuals that you would expect to be heterozygous for the Rhesus gene. **(1½ marks)**

let p represents frequency of dominant/Rhesus positive allele
q represents frequency of recessive/Rhesus negative allele
p^2 represent frequency of the dominant genotype
q^2 represent frequency of the Homozygous recessive genotype
2pq represent frequency of heterozygotes
q^2 represent the frequency of Rhesus negative individuals;
$\Rightarrow q^2 = \frac{16}{100} = 0.16;$
$q = \sqrt{0.16} = 0.4;$✓
From p + q = 1
p = 1 – 0.4= 0.6.✓
Heterozygotes
2pq = 2×0.6×0.4= 0.48, 48%;✓ ***@ 1½ mark***

3. (a) Of what advantage is maintenance of relatively small body size among locomoting organisms? **(2marks)**

Reduced problems of support;✓
Expends less energy during locomotion;✓ ***@ 1mark***

(b) Explain how buoyancy can be achieved in chondrichthyes that lack swim bladders. **(3marks)**

Having a larger ventral lobe than dorsal lobe of the caudal fin;✓✓ ***making the tail asymmetric/ forming a heterocercal tail;***✓ ***which provides an upthrust;***✓ ***allowing it to maintain its vertical position in water;***✓***provided the fish keeps swimming;***✓ ***@ ½ mark***

(c) Describe the role of the following in bringing about contraction of a skeletal muscle fibre.

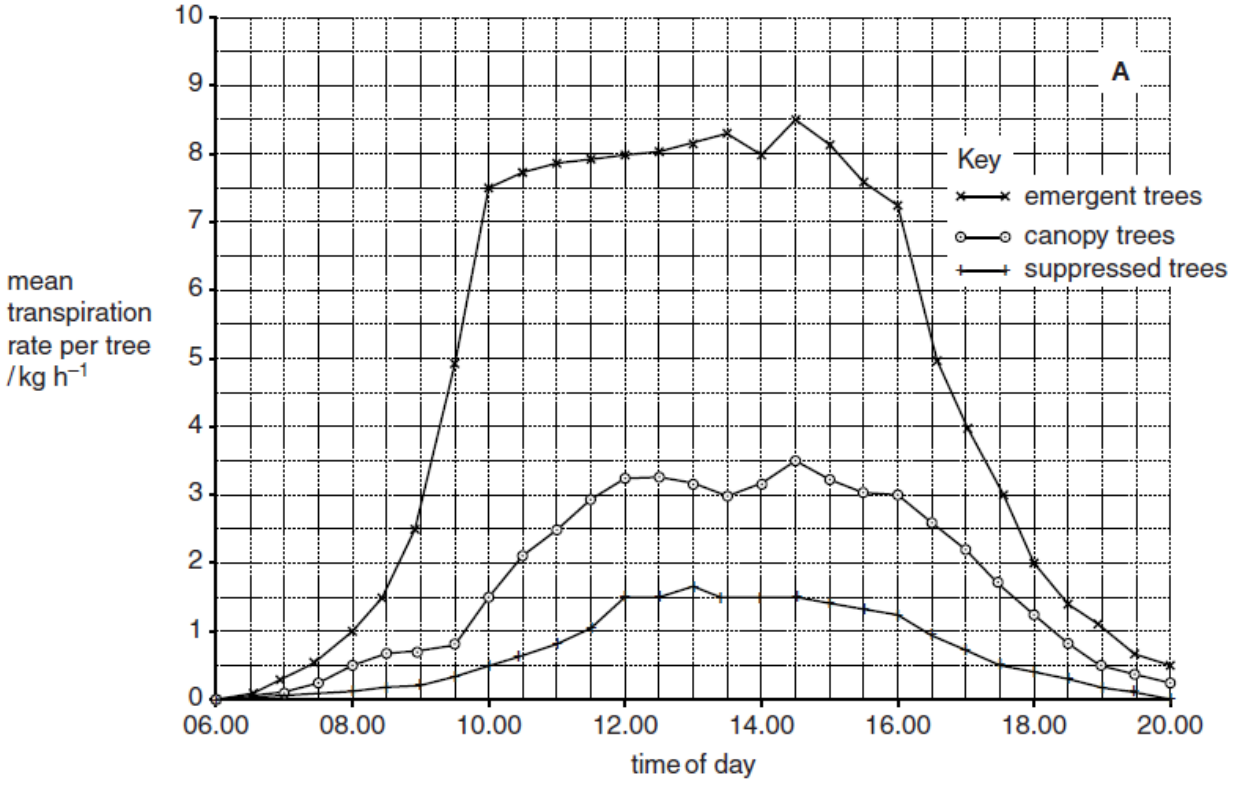
(i) Acetylcholine. (**3marks**)

On attachment onto protein receptor molecule on folds of the muscle fibre membrane/sarcolemma/post synaptic membrane;✓ protein receptor changes shape;✓ increasing the permeability of the membrane to sodium ions/ Sodium ions diffuse into the sarcoplasm via opened sodium ion channels;✓ causing local depolarization of the sarcolemma;✓ @ 1mark

(ii) ATP. (**2marks**)

On hydrolysis,✓ provides energy for activating/cocking the myosin head;✓ and active transport/pumping of calcium ions from the sarcoplasm back to the sarcoplasmic reticulum and T system;✓ for the muscle fibre to relax;
On attachment on the myosin head;✓ myosin head detaches from the actin filament;✓ @ ½ mark

4. The graph in the figure below shows rates of transpiration of emergent (tallest), canopy (forming a thick canopy of leaves) and suppressed (not reaching the canopy) trees in a forest cover over a 14-hour period. Study it carefully and answer the questions that follow.



(a) Compare the transpiration rates of the emergent and suppressed trees over the 14-hour period. (**4marks**)

Similarities.
In both emergent and suppressed trees, rate of transpiration,
Are equal initially/at 06.00hrs;✓
Attain peak;✓
Decrease from 14.50hrs to 20.00hrs;✓
Increase from 06.00hrs to 12.00hrs;✓ and 12.50hrs to13.00hrs;✓
Differences

Rate of transpiration of emergent trees	Rate of transpiration of suppressed trees
Higher from 06.00hrs to 20.00hrs ✓	***Lower from 06.00hrs to 20.00hrs***
Decreases rapidly from 14.50hrs to 20.00hrs ✓	***Decreases gradually from 14.50hrs to 20.00hrs***
Attains two peaks ✓	***Attains one peak***
First peak attained later /at 13.50hrs ✓	***Peak attained earlier/at 13.00hrs***

Award for two correct similarities and two differences

(b) Explain the difference in the rates of transpiration of the emergent trees and suppressed trees over the 14-hour period. (**4marks**)

Rate of transpiration of emergent trees is higher than that of suppressed trees;✓ because emergent trees are exposed to higher light intensities;✓ more stomata open;✓ lower humidity;✓ increasing diffusion/water potential gradient;✓ higher temperatures;✓ more latent heat which heats up water;✓ converting it to vapour;✓ higher wind velocity;✓ water vapour is blown away;✓ increasing diffusion gradient;✓ all causing a more transpirational loss of water in emergent trees than suppressed trees;✓
Emergent trees have longer roots; absorbing more water;✓ and with more leaves;✓ larger surface area availed for stomatal water loss;✓
@ ½ mark for any well explained three environmental factors

(c) Explain why transpiration is often described as an "inevitable consequence of gaseous exchange in plants". (**2marks**)

Stomata opens allowing carbon dioxide uptake;✓✓ a raw material for photosynthesis;✓ water vapour diffuses out of the opened stomata;✓
@ ½ mark

5. (a) (i) What is meant by term **blue baby condition**? (**1mark**)

Condition in which oxygen transportation in blood is impeded resulting into cyanosis (blueness of skin) in babies;✓

(ii) Explain **two** causes of the blue baby condition in humans.

(**3marks**)

Congenital heart defect;✓ in which foramen ovale and/or ductus arteriosus fail to close soon after birth;✓ allowing a proportion of blood to bypass the lungs;✓ depriving the tissues of sufficient oxygen;
Nitrate poisoning;✓ in babies fed on nitrate rich food/nitrate contaminated water; whose very sensitive and less developed gastrointestinal tract covert nitrate to nitrites,✓ which bind to haemoglobin producing methemoglobin which does not easily release oxygen into blood stream; causing hypoxemia;✓ ***@ ½ mark***

(b) Explain how the placenta functions as

(i) Small intestine. (**1mark**)

Allows absorption of nutrients (amino acids, glucose, minerals, vitamins) from mother's blood into the fetal blood;✓ to nourish the developing foetus;✓

(ii) An endocrine gland. (**1mark**)

Secretes Human chorionic gonadotrophin;✓ progesterone;✓ and oestrogen;✓
Award for any two correct hormones

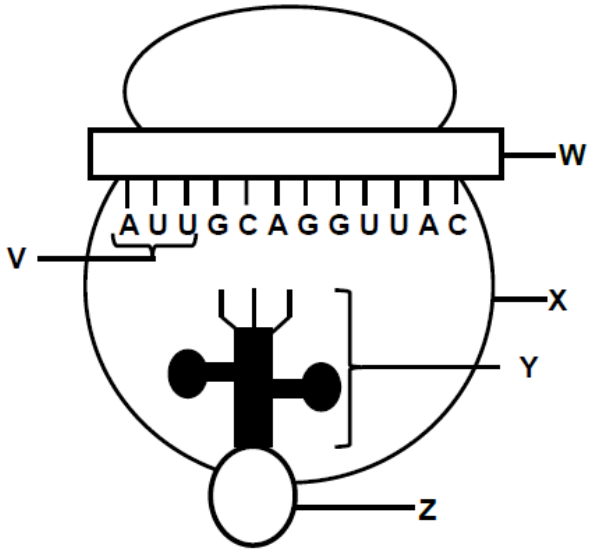
(iii) Lung. (**2mark**)

Allows diffusion of carbon dioxide from fetal blood into maternal blood, for excretion;✓
Allows diffusion of oxygen from maternal blood into fetal blood;✓

(c) The blood supply of the mother and of the fetus are kept separate from each other at the placenta. Suggest and explain reasons why these two blood systems must not be joined together. **(2marks)**

Mother's blood is at higher pressure than fetal blood;✓ thus prevents bursting of the fetal vessels;✓
Mother's blood can be of different blood groups to fetal blood;✓ thus prevents agglutination of fetal blood; blocking the vital organs such as kidney; which can prove fatal;✓
Mother's blood can carry pathogens;✓ thus no direct transfer of pathogens;✓
Mother's blood carry toxins/drugs;✓ thus no direct transfer of toxins; ✓
Award for any two

6. The diagram below shows a stage during protein synthesis in a eukaryotic cell.



(a) Name

(i) Organelle **X.** **(½ mark)**

Ribosome;✓

(ii) Molecules **W** and **Y.** **(1mark)**

W- ***messenger RNA/mRNA*****;**✓
Y-*transfer RNA/tRNA*;✓

(iii) the monomer of molecule **W.** **(½ mark)**

***Nucleotide*;**✓
Award for correct label of W in a (ii).

(b) (i) State the stage of protein synthesis illustrated above, giving where it occurs in the cell. (**2marks**)

Translation;✓ ***occurring on the ribosomes in the cytoplasm***;✓

(ii) Outline **three** differences between the stage in b(i) above and DNA replication. (**3marks**)

Translation	DNA replication
Occurs on the ribosomes in the cytoplasm ✓	***occurs in the nucleus***
Polypeptide chain of amino acids/protein is formed ✓	***Two identical copies of DNA are formed***
Template molecule is mRNA ✓	***Template molecule is DNA***
Read direction is 5' to 3' on the mRNA template ✓	***Read direction is 3' to 5' on the DNA template***

(c) When a sample of DNA is extracted from a cell, chemical analysis showed that 38% were adenine.

(i) To which group of organic bases is adenine found. Give a reason for your answer. (**1mark**)

Purines;✓ consist of double/2 (Six- membered and five-membered) nitrogen containing rings;✓ ***@ ½ mark***

(ii) Calculate the percentage of guanine base. (**2marks**)

Percentage of Thymine = 38%;✓ (Ratio of Guanine to cytosine, 1:1)
Total percentage of Adenine and Thymine= 76%;✓
Percentage of Cytosine and Guanine= 100-76=24%;✓
Ratio of Guanine to cytosine= 1:1;
Percentage of guanine = ½ X 24= 12%;✓
@ ½ mark

END