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

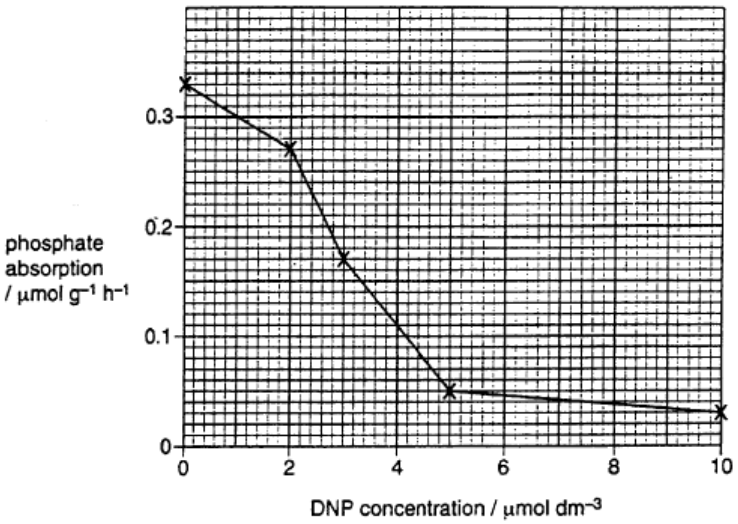
Instructions

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

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

1. The graph in the figure below shows the rate of phosphate absorption by barley roots placed in solutions containing different concentrations of 2,4-dintrophenol. (DNP)

   DNP is an uncoupler of electron transport chain. Each solution was aerated with 21% of oxygen.




(a) Describe the effect of different concentrations of DNP on the rate of phosphate absorption. (**3marks**)

***Increase in DNP concentration from 0µmoldm$^{-3}$ to 2µmoldm$^{-3}$, gradually decreases rate of phosphate absorption;✓***
***Increase in DNP concentration from 2µmoldm$^{-3}$ to 5µmoldm$^{-3}$, rapidly decreases rate of phosphate absorption;✓***
***Increase in DNP concentration from 5µmoldm$^{-3}$ to 10µmoldm$^{-3}$, slightly/gradually decreases rate of phosphate absorption;✓@ 1mark***

(b) Explain the effect of different concentrations of DNP on the rate of phosphate absorption. (**3marks**)

***Increase in DNP concentration from 0µmoldm$^{-3}$ to 10µmoldm$^{-3}$ decreases rate of phosphate absorption;✓ DNP is a***

***protonophore/proton translocator;✓ allowing protons to leak from the intermembrane space into the mitochondrial matrix;✓ bypassing chemiosmotic channels;✓ ATP synthesis is less efficient;✓ as most of energy is wasted as heat;✓ availing little/no ATP for active absorption of phosphate ions;✓*** ***@ ½ mark***

(c) Briefly describe the movement of phosphate ions once inside the barley roots. (**2marks**)

***Carried up in solution through cytoplasm (symplast pathway) of the endodermal cells to the xylem;✓ by facilitated diffusion;✓ and active transport;✓ then to other plant parts by mass flow in the transpiration stream;✓*** ***@ ½ mark***

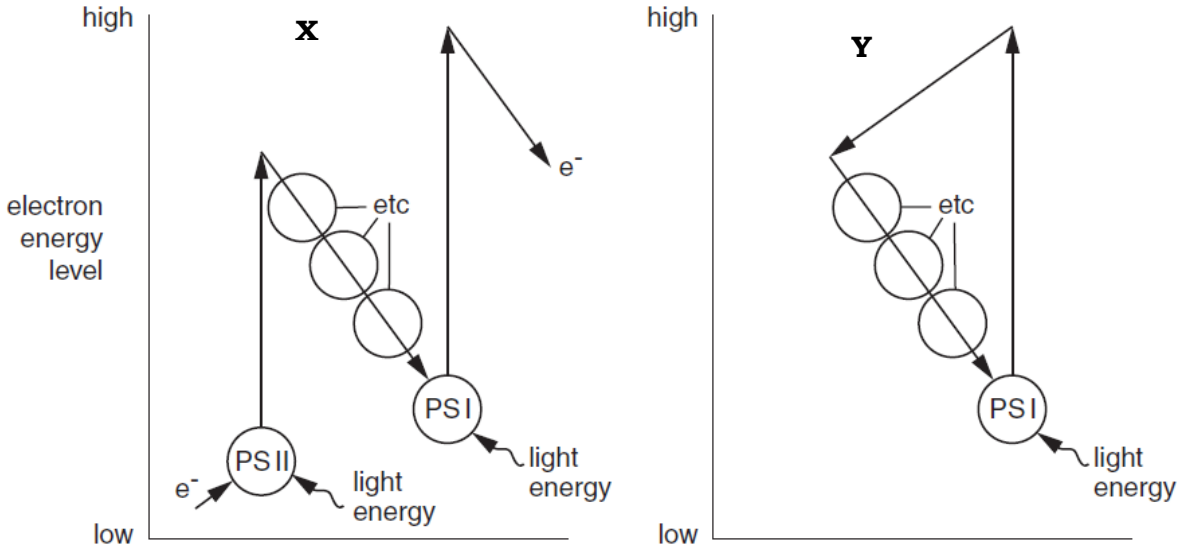
(d) Of what significance are phosphate ions to plants? (**2marks**)

***Component of***

***nucleic acids/nucleotide (DNA and RNA);✓***
***Adenosine triphosphate, an energy store for chemical reactions in plants;✓***
***phospholipids in cell membrane;✓***
***several coenzymes, (NADP);✓***
***secondary messenger, Cyclic AMP;✓***

***Any correct two @ 1mark***

2. Figure below shows the flow of electrons in photophosphorylation during light dependent stage of photosynthesis.




(a) State the precise location of photophosphorylation in the chloroplast. (**1mark**)

***Thylakoid membrane of the chloroplast grana;✓***

***Rej Thylakoid or Grana alone.***

(b) Giving **one** reason in each case, identify the type of photophosphorylation labeled **X** and **Y**. (**3marks**)

(i) **X**- ***Non-cyclic photophosphorylation***;✓✓

Reason

***Non-cyclic flow of electrons;***✓
***Two photosystems/Uses photosystems I and II;***

(ii) **Y**-***Cyclic photophosphorylation***;✓✓

Reason

***Cyclic flow of electrons;***✓
***One photosystem/ uses photosystem I;***
***In both cases, deny marks for Cyclic and non-cyclic alone. Correct reasons if type of photophosphorylation is wrongly identified. @ ½ mark***

(c) Describe the role of light in photophosphorylation. (**2marks**)

***Provides energy which splits water molecule;***✓ ***into hydrogen ions(protons) and electrons; releasing oxygen***;✓
***Excites electrons;***✓ ***passed downhill along a chain of electron carriers; losing their energy used in ATP synthesis***;✓ ***@ ½ mark***

(d) Give **four** differences between photophosphorylation and oxidative phosphorylation. (**4marks**)

| Photophosphorylation | Oxidative phosphorylation |
|---|---|
| ***Uses energy from sun light*** ✓ | ***Uses energy from oxidation of organic compounds*** |
| ***First electron donor is water*** ✓ | ***First electron donor is hydrogen*** |
| ***Products are ATP, oxygen and NADPH*** ✓ | ***Products are ATP and water*** |
| ***Last electron acceptor is NADP*** ✓ | ***Last electron acceptor is oxygen*** |
| ***occurs in the chloroplast*** ✓ | ***occurs in the mitochondria*** |
| ***occurs in plants only*** ✓ | ***occurs in all organisms*** |
| ***Hydrogen acceptors is NADP*** ✓ | ***Hydrogen acceptors are NAD and FAD*** |
| ***Oxygen is released*** ✓ | ***Oxygen is utilised*** |

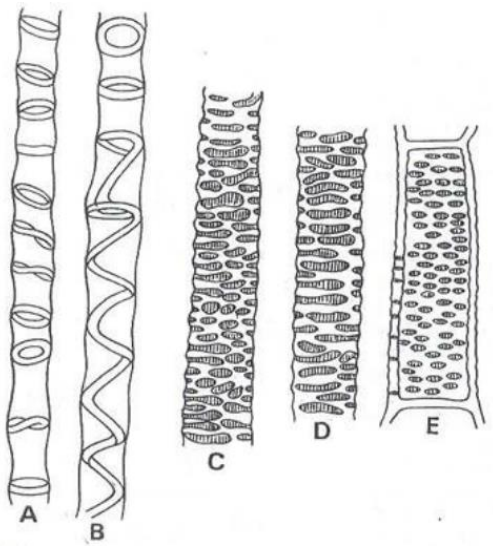
3. (a) Outline **three** salient features of a stem epidermal cell. (**1½ marks**)

***One cell thick/single layer of cells;***✓
***Compact;***✓
***Elongated and flattened;***✓
***Thin outer cellulose cell wall impregnated with cutin;***✓
***Tightly packed, with no intercellular spaces between them;***✓
***Deny marks for features of plant cells such as Large central vacuole, peripheral cytoplasm.*** ***@ ½ mark***

(b) Describe the significance of hairs that occasionally grow on the epidermis of plants. (**3marks**)

***Increase surface area for absorption of water and mineral salts by plant roots;***✓
***Prevents climbing stems of goose grass from slipping off their support;***✓
***Trap a layer of moist air next to a plant; decreasing diffusion gradient for transpirational water loss;***✓
***Form barriers around the nectaries of flowers, preventing access to crawling insects thus promoting cross pollination by larger flying insects;***✓
***Give plants scents e.g. in leaves of lavender;***✓
***Secrete sticky substances that traps and kills insects; digested and end products of digestion absorbed. e.g. hair glands of a potato leaf;***✓
***Any three @ 1mark***

(c) Below are different patterns of lignin deposition in a xylem vessel. Study them and answer the questions that follow.




(i) Identify the lignin deposition patterns shown above. (**2½ marks**)

**A-** ***Annular;***✓
**B-** (***Partly) helical;***✓ ***Acc Partly annular;***
***C-*** ***Reticulate;***✓
**D-** ***Scalariform;***✓
***E-*** ***Pitted;***✓ ***@ ½ mark***

(ii) How is lignin deposition an adaptive significance on the transport role of the xylem vessel? (**3marks**)

***Offers xylem vessels a great tensile strength; preventing them from collapsing when conducting water under tension;***✓
***Increase adhesive forces for upward movement of water;***✓

4. (a) What is meant by the following terms as used in hormonal action.

(i) Cascade effect. (**1mark**)

***Amplification of the hormone's response by a chain of reactions initiated by a single hormone in which the enzyme molecule activates many of its substrates which become the next enzyme in the chain such that a small signal on the cell surface membrane produces a very large response***;✓✓

(ii) Cell signaling. (**1mark**)

***Process of cellular communication within the body driven by release of a hormone (signaling molecule) from a cell, received/taken up by another cell;***✓✓

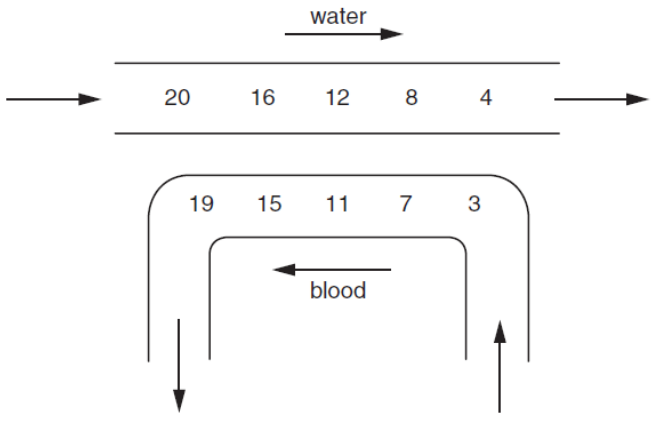
(b) Give the **three** main stages of cell signaling. (**3marks**)

***Reception/binding of signal molecule to the receptor;***✓
***Intracellular signal transduction/Chemical signal causes a cascade of enzyme activities;***✓
***Cellular response;***✓ ***@ 1mark***

(c) How does insulin signal glucose uptake by skeletal muscle? ((**5marks**)

***Attaches to a glycoprotein receptor;***✓ ***on the cell surface membrane;***✓ ***stimulating tyrosine kinase;***✓ ***initiating a phosphorylation cascade;***✓ ***cytoplasmic vesicles containing glucose transporters rapidly fuses with cell surface membrane;***✓ ***increasing transport of glucose from blood into the skeletal muscle***;✓ ***@ 1mark***

5. Figure below shows how blood and water flow through the gills. The numbers represent the partial pressure of oxygen.




(a) Identify the type of flow system above. (**1mark**)

***Counter –current flow***;✓

(b) Explain how the flow system named in (a) above increase the efficiency of gaseous exchange. (**4marks**)

***Blood and water flow in opposite direction across the gills;✓ highly oxygenated water comes into contact with poorly oxygenated blood;✓ maintaining a steep oxygen concentration gradient across the whole gill plate;✓ allowing blood to be maximally saturated with oxygen as it leaves the gill plate;✓*** ***@ 1mark***

(c) How is the gill filament structurally suited to its function? (**3marks**)

***Moist allowing dissolution of respiratory gases and diffusion in solution form;✓***
***Highly vascularized increasing concentration gradient for maximum gaseous exchange;✓***
***Are interlocked/packed closely to slow water flow allowing maximum extraction of oxygen from water by blood;✓***
***Numerous (secondary) gill lamellae increasing surface area for gaseous exchange;✓***
***Thin; reducing the distance of diffusion of respiratory gases;✓***
***Any three structural adaptation*** ***@ 1mark***

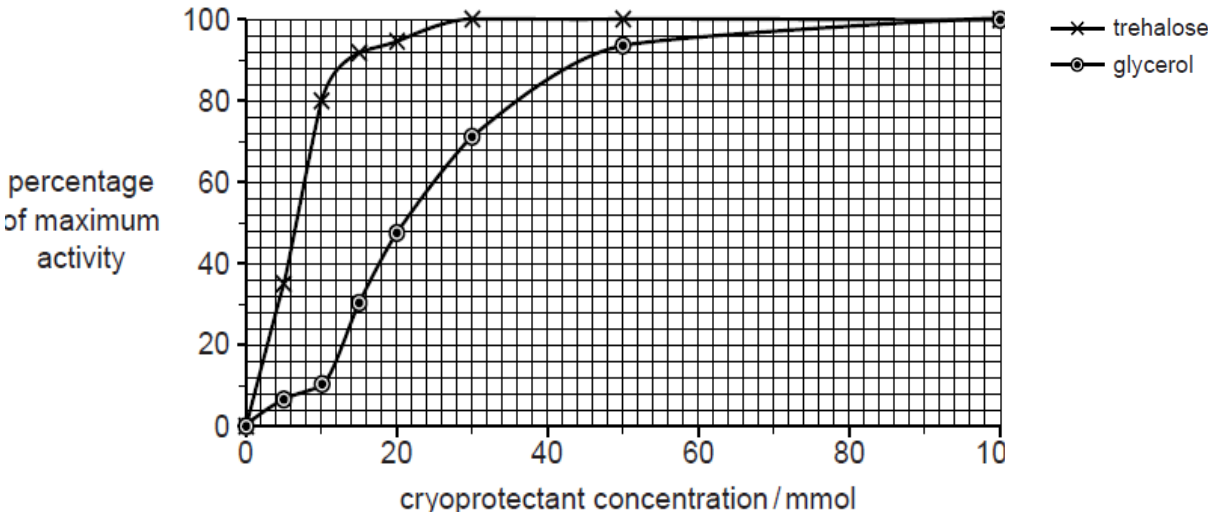
(d) Suggest why fish dies when brought out of water? (**2marks**)

***Gill lamellae collapse/stick together;✓✓ decreasing their surface area for efficient gaseous exchange;✓ suffocating fish;✓*** ***@ ½ mark***

6. An investigation was carried out on the protective effects given by different concentrations of two cryoprotectants, *trehalose* (a disaccharide synthesized from two $\alpha$-glucose molecules) and *glycerol*, on a respiratory enzyme.

The enzyme was subjected to a freezing temperature and then returned to its optimum temperature. The activity of the enzyme was then measured at its optimum temperature.

The results of the investigation are as shown in the graph below



(a) Why is trehalose and glycerol referred to as cryoprotectants? (**1mark**)

***Are substances that offer protection to biological tissues; from detrimental effects of intercellular ice crystal formation; during freezing and thawing;***✓

(b) Compare the effects of the two cryoprotectants on the activity of the respiratory enzyme. (**4marks**)

**Similarities**

***For both Trehalose and glycerol,***
***-Increase in concentration, from 0mmol to 83mmol; increases the percentage of maximum activity;***✓
***-Maximum percentage of maximum activity is attained /maximum percentage enzyme recovery is attained;***✓
***-Maximum percentage of maximum activity is attained at the same concentration/83mmol;***✓
***-At 0mmol concentration, percentage of maximum activity are equal;***✓

**Differences**

| Trehalose | Glycerol |
|---|---|
| ***Increase in concentration from 0mmol to 10mmol, rapidly increases the percentage of maximum activity*** ✓ | ***Increase in concentration from 0mmol to 10mmol, gradually increases the percentage of maximum activity*** |
| ***Percentage of maximum activity is higher from 0mmol to 83mmol;*** ✓ | ***Percentage of maximum activity is lower from 0mmol to 83mmol*** |
| ***Increase in concentration from 30mmol to 83mmol, percentage of maximum activity remains constant;*** ✓ | ***Increase in concentration from 30mmol to 83mmol, gradually increases percentage of maximum activity*** |

***Award for any two correct similarities and differences***.

(c) Explain the difference in the effects of the two cryoprotectants on the activity of the respiratory enzyme. (**3marks**)

***From 0mmol to 83mmol, percentage of maximum activity is higher in Trehalose than glycerol;***✓ ***because Trehalose has better cryoprotecting properties than glycerol, e.g. existence of a number of polymorphs, (crystalline and amorphous forms);***✓ ***thus constantly changing from one form to another;***✓ ***without affecting crystallinity;***✓ ***higher glass transition temperatures;***✓ ***allowing to fully encapsulate the enzyme, restricting more the mobility of the enzyme, giving it more stability under lower temperatures;***✓ ***@ ½ mark***

(d) How would the molecular structure of the respiratory enzyme change in the absence of the cryoprotectants? (**2marks**)

***Tertiary structure is lost;***✓ ***as hydrogen and ionic bonds are broken;***✓ ***altering the shape of the active site of the enzyme;***✓ ***respiratory substrate unable to fit;***✓
***Hydrophilic groups no longer interact with water molecules;***✓
***Hydrophobic groups to outside of the molecule;***✓
***Award for any two @ 1mark***

**END**