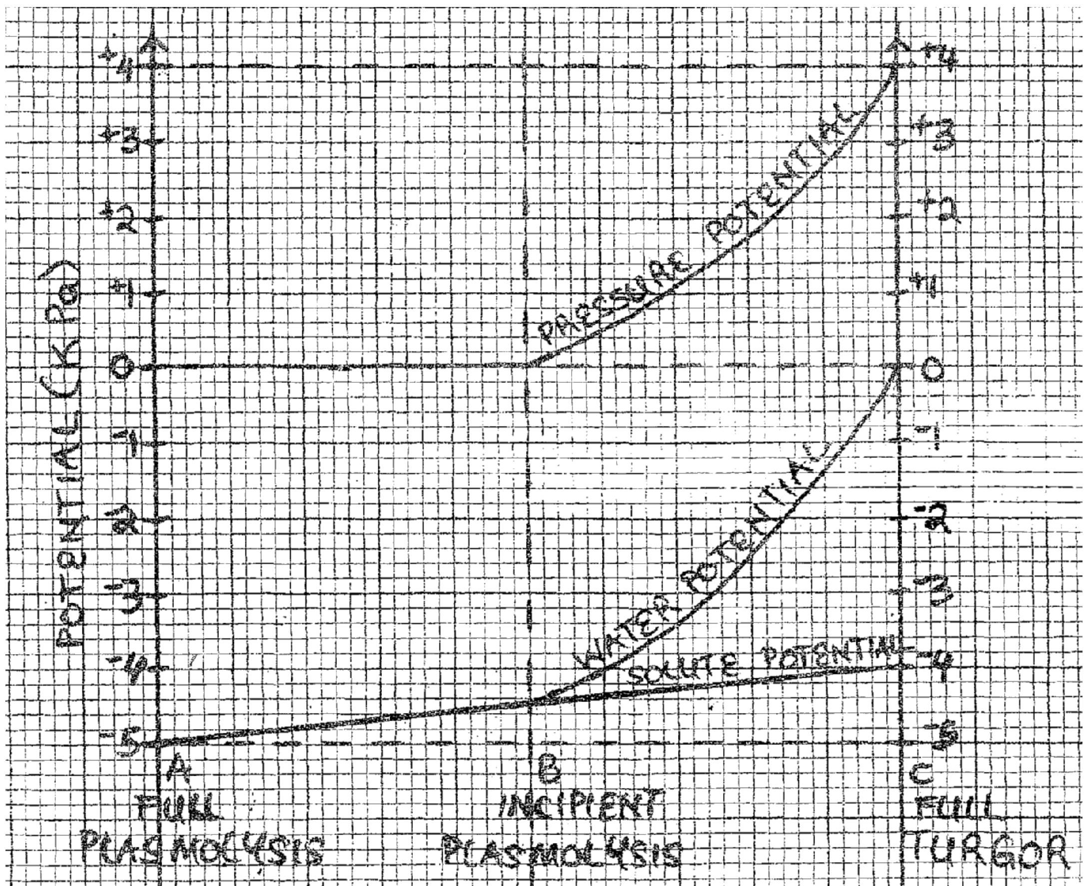
MOVEMENT IN AND OUT OF CELLS

EXAMINATION 7

SECTION A (40 MARKS)

1. *The graphs below show changes in the different potentials of a fully plasmolysed plant cell in a hypotonic solution:*



(a) Describe the shape of each of the following graphs:

(i) Pressure potential. ***(01 mark)***

(ii) Water potential. ***(01 mark)***

(iii) Solute potential. ***(01 mark)***

(b) Define each of the following terms

(i) Water potential. ***(02 marks)***

(ii) Solute potential. ***(02 marks)***

(iii) Pressure potential. ***(02 marks)***

(c) Explain the shape of the graph of:

(i) Solute potential. ***(10 marks)***

(ii) Pressure potential. ***(03 marks)***

(iii) Water potential. ***(10 marks)***

(d) (i) Define osmosis in terms of water potential. ***(02 marks)***

*(ii) Explain why the osmotic potentials of solutions are always negative.****(06 marks)***

EXAMINATION 8

SECTION A (40 MARKS)

2. The table below shows results of an experiment to determine the solute potential of onion epidermal cells using incipient plasmolysis method.
In each case, the total number of cells observed in one field of view was eighty (80).

Concentration of sucrose solution (mol /dm^3)	**Number of cells plasmolysed**	**Percentage plasmolysis**
0.1	0	
0.2	0	
0.3	2	
0.4	3	
0.45	10	
0.50	60	
0.55	80	
0.60	80	

(a) Copy and complete the table by working out the percentage of cells which are plasmolysed. **(04 marks)**

(b) What is meant by the terms?
(i) Solute potential. **(03 marks)**
(ii) Incipient plasmolysis. **(03 marks)**

(c) (i) Plot a graph to show the relationship between percentage of plasmolysed cells and sucrose concentration. **(08 marks)**
(ii) From the graph, determine the concentration of the onion epidermal cells to be used to determine their solute potential. **(02 marks)**
(iii) Briefly explain how you arrived at your answer in (c) (ii) above. **(08 marks)**

(d) Explain the ecological significance of osmosis to plants. **(06 marks)**

e) Briefly describe the role played by water in stomatal opening. **(06 marks)**

EXAMINATION 9
SECTION A (40 MARKS)

3.. Mammalian red blood cells transferred from blood plasma to a less concentrated solution swell, and if they swell sufficiently, they burst; in which case they are said to have haemolysed. And when comparable discs of potato tuber are placed in sucrose solutions of varying concentrations, their mass changes.

The table below shows the percentage of red blood cells haemolysed and the percentage change in mass of discs of potato tuber separately placed in a series of sucrose solutions ranging from 0.0 to 0.6M in covered dishes at a constant temperature of 20^{0}C:

Concentration of sucrose solution (mol/dm^3)	**Percentage of red cells haemolysed**	**Percentage change in mass of potato tuber discs**
0.0	100	+22
0.1	90	+17
0.2	80	+9
0.3	68	+3
0.4	30	-3
0.5	16	-10
0.6	0	-15

(a) *Represent the information graphically using the same set of axes.* ***(08 marks)***
(b) *From your graph determine:*
(i) The sucrose concentration at which the proportion of haemolysed to non-haemolysed cells are equal. ***(01 mark)***
(ii) The sucrose concentration that has an osmotic potential equal to the mean water potential of the cells of the potato tuber tissue. ***(01 mark)***
(c) *Fully explain how you arrived at your answers in (b) (i) and (b) (ii).* ***(05 marks)***
(d) *Give an explanation of each of the following :*
(i) Red blood cells placed in a 0.0M sucrose solution swell and burst while plant cells do not. ***(07 marks)***
(ii) Red blood cells haemolyse over a range of sucrose solution concentrations rather than at one particular sucrose concentration. ***(03 marks)***
(iii) Positive percentage changes in mass of potato tuber discs. ***(03 marks)***
(iii) Negative percentage changes in mass of potato tuber discs. ***(03 marks)***
(e) *Suggest reasons why:*
(i) The dishes containing the red blood cells or potato tuber discs are covered during the experiments. ***(02 marks)***
(ii) The solutions are kept at a constant temperature of 20^{0}C during the experiments. ***(02 marks)***
(iii) The change in mass of potato tuber discs is expressed as a percentage change. ***(02 marks)***
(f) *Other than change in mass, briefly explain three other observable changes that are registered when potato tuber discs are treated with sucrose solutions of varying concentrations.* ***(03 marks)***

SECTION B (60 MARKS)
3. (a) (i) Define the term active transport. ***(02 marks)***
*(ii) Describe the sodium-potassium pump as an example of active transport.****(07 marks)***
(b) Define the terms uniport carrier, symport carrier and antiport carrier. ***(06 marks)***
(c) With an example, explain the process of cotransport. ***(05 marks)***

4. (a) Describe what happens when a fully turgid plant cell is inserted in a hypertonic solution. ***(10 marks)***
(b) How does plasmolysis differ from wilting? ***(04 marks)***
(c) Explain the effects of water stress in plants. ***(06 marks)***

EXAMINATION 10
SECTION A (40 MARKS)
5.. In an experiment to determine the water potential of a plant tissue, 1cm strips of ***Narcissus*** *sp. flower were totally immersed in a series of sucrose solutions of known concentration contained in covered petri dishes kept at* ***20^{0}C****.*
After 24 hours, the length of the tissue was measured and the results are as shown in the ***table I*** *below:*
Table I:

Concentration of sucrose solution (mol dm^{-3})	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Length of flower strip after 24 hours (cm)	1.9	1.7	1.2	0.8	0.75	0.7	0.7
Change (+ or-) in length of flower strips (cm)	0.9						

Table II below shows the solute potentials of given sucrose solutions at ***20^{0}C:***
Table II:

Molarity (mol dm^{-3})	*0.20*	*0.25*	*0.30*	*0.35*	*0.40*	*0.45*	*0.50*	*0.55*
Solute potential (KPa)	*-540*	*-680*	*-860*	*-970*	*-1120*	*-1280*	*-1450*	*ˉ1620*

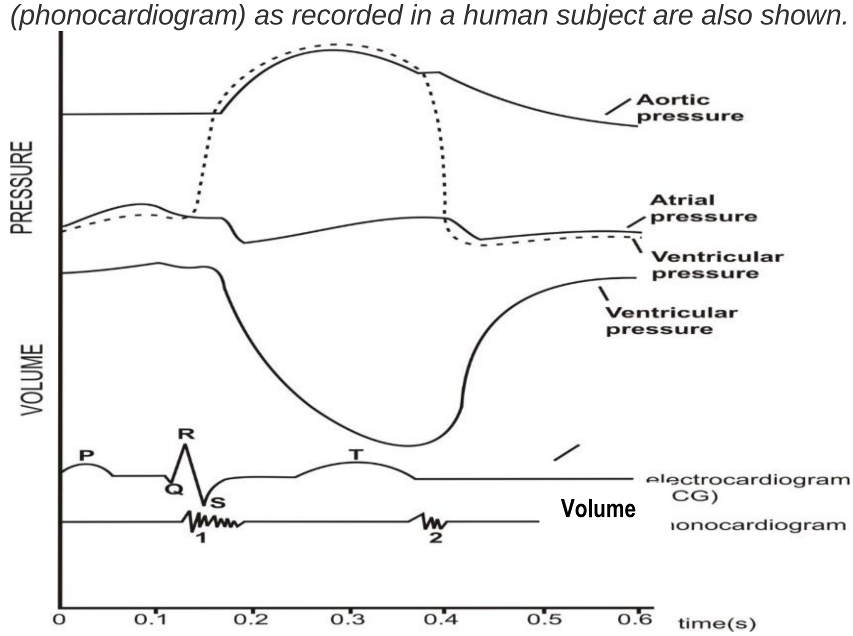
Molarity (mol dm-3)	*0.60*	*0.65*	*0.70*	*0.75*	*0.80*
Solute potential (KPa)	*-1800*	*-1980*	*-2180*	*-2370*	*-2580*

(a) (i) Define the terms water potential and solute potential. ***(04 marks)***
(ii) Comment on the relationship between the molarity and solute potential of sucrose solutions as shown in ***table II.*** ***(12 marks)***

(b) (i) Copy and complete ***table I.*** ***(04 marks)***
(ii) Plot a graph to show the change in length of flower strip with sucrose solution concentration. ***(08 marks)***
(iii) Determine the water potential of the plant tissue, giving a full explanation of how you arrive at your answer. ***(12 marks)***

6. *The figure below shows the pressure and volume changes that occur during the mammalian cardiac cycle (of a dog). The pressure changes were measured in the left atrium and ventricle and the aorta. Volume changes were also measured for both ventricles.*

The electrical activity in the heart wall (electrocardiogram) and heart sounds (phonocardiogram) as recorded in a human subject are also shown.



(a) Describe the changes in:

(i) Atrial pressure

(ii) Ventricular pressure

(b) Compare the changes in ventricular pressure and ventricular volume between

0.1 Seconds and 0.5 seconds.

(c) *Explain the effect of the changes in atrial, aortic and ventricular pressures to blood flow during the cardiac cycle.*

(d) *What is the significance of the relationship between aortic and ventricular pressure?*

(e) *What is represented by the:*

 (i) *Waves on the electrocardiogram?*

 (ii) *Sounds 1 and 2 on the phonocardiogram?*

(f) *Explain three factors that ensure efficient flow of blood within the mammalian heart.*

SOLUTION

6.. (a) (i) Changes in atrial pressure

- *Initially at 0 seconds atrial pressure is low.*
- *From 0 seconds to 0.08 seconds atrial pressure increases gradually to a peak.*
- *From 0.08 seconds to 0.14 seconds atrial pressure decreases gradually.*
- *From 0.14 seconds to 0.16 seconds atrial pressure increases very gradually to a peak.*
- *From 0.16 seconds to 0.19 seconds atrial pressure decreases rapidly.*
- *From 0.19 seconds to 0.4 seconds atrial pressure increases gradually to a peak*
- *From 0.4 seconds to 0.44 seconds atrial pressure decreases rapidly.*
- *From 0.44 seconds to 0.58 seconds atrial pressure increases very gradually to a peak*
- *From 0.58 seconds to 0.6 seconds atrial pressure decreases very gradually*

(ii) Changes in ventricular pressure

- *Initially at 0 seconds ventricular pressure is low.*
- *From 0 seconds to 0.08 seconds ventricular pressure increases gradually to a peak.*
- *From 0.08 seconds to 0.14 seconds ventricular pressure decreases very gradually.*
- *From 0.14 seconds to 0.16 seconds ventricular pressure increases very rapidly.*
- *From 0.16 seconds to 0.28 seconds ventricular pressure increases rapidly to a peak.*
- *From 0.28 seconds to 0.38 seconds ventricular pressure decreases gradually.*
- *From 0.38 seconds to 0.42 seconds ventricular pressure decreases very rapidly.*
- *From 0.42 seconds to 0.58 seconds ventricular pressure increases very gradually to a peak.*
- *From 0.58 seconds to 0.6 seconds ventricular pressure decreases very gradually.*

(b) Differences in changes in ventricular pressure and ventricular volume

- *From 0.14 seconds to 0.16 seconds ventricular pressure increases very rapidly, while ventricular volume increases very gradually.*
- *From 0.16 seconds to 0.28 seconds ventricular pressure increases, while ventricular volume decreases.*
- *From 0.42 seconds to 0.5 seconds ventricular pressure increases very gradually, while ventricular volume increases very rapidly.*
- *From 0.38 seconds to 0.42 seconds ventricular pressure decreases, while ventricular volume increases.*
- *Ventricular pressure attains a peak later at 0.28 seconds, while ventricular volume attains a peak earlier at 0.16 seconds.*

(c) Effect of changes in atrial, aortic and ventricular pressures

- *From 0 seconds to 0.14 seconds the cardiac muscle in the wall of the left atrium contracts during atrial systole, atrial volume decreases, and atrial pressure increases and exceeds ventricular pressure, forcing the bicuspid value to open, and so oxygenated blood flows from the left atrium into the relaxed left ventricular through the open bicuspid valve.*

- *From 0.14 seconds to 0.38 seconds the cardiac muscle in the wall of left ventricle contracts more powerfully than the atrial wall during ventricular systole, ventricular volume decreases, and ventricular pressure increases, and exceeds atrial pressure at 0.14 seconds, forcing the bicuspid valve to close, preventing backflow of blood into the left atrium; and as ventricular pressure increases further ventricular pressure exceeds aortic pressure at 0.16 seconds, forcing the semilunar/aortic valve of the aorta to open, and oxygenated blood is pumped from the left ventricle into the aorta.*

- *From 0.38 seconds to 0.6 seconds the cardiac muscle in the wall of the left ventricle relaxes during diastole, the ventricular volume increases, and so ventricular pressure decreases, and falls below aortic pressure at 0.38 seconds, forcing the semilunar/aortic valve of the aorta to close, preventing backflow of blood into the left ventricle; and ventricular pressure decreases further and falls below atrial pressure at 0.4 seconds, forcing the bicuspid valve to open, and oxygenated blood flows from the left atrium into the left ventricle.*

(d) (i) Waves on the electrocardiogram

- ***P wave** corresponds to the wave of electrical excitation spreading over the atria during atrial systole/contraction.*
- ***QRS wave** corresponds to the wave of electrical excitation spreading over the ventricles during ventricular systole/contraction.*
- ***T wave** corresponds to the wave of electrical excitation spreading over the ventricles during ventricular diastole/relaxation.*

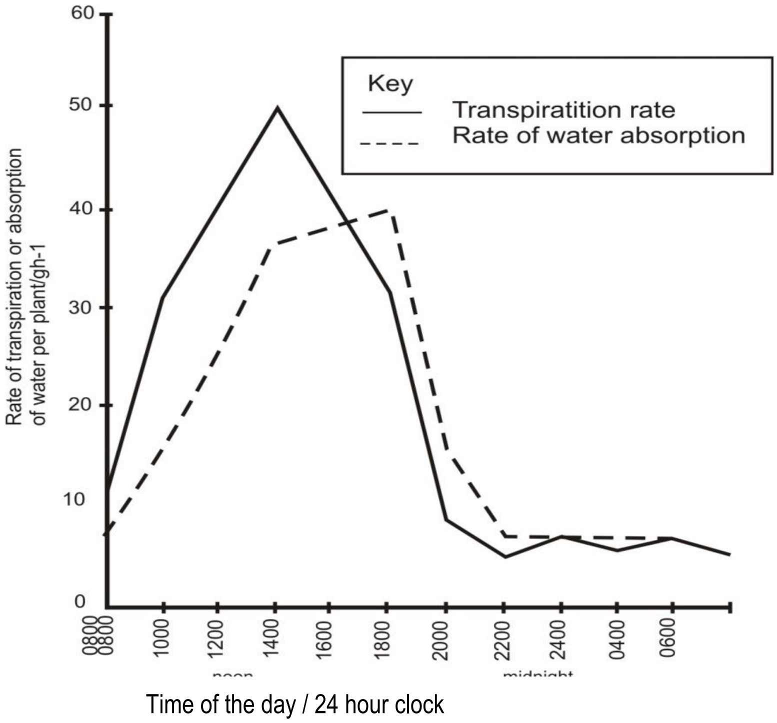
(ii) Sounds on the phonocardiogram

1 is the first heart sound produced by the sudden closure of the atrioventricular valves, described as the 'lub'
2 is the second heart sound produced by the sudden closure of the semilunar valves of the aorta and pulmonary artery, described as the 'dub'

(f) Factors ensuring efficient flow of blood within the mammalian heart

- *Myogenic initiation of the contraction of cardiac muscle by the sinoatrial node/SAN ensures continuous and rhythmic contraction and relaxation without stopping.*
- *Rhythmic contraction and relaxation of heart chambers creates an orderly pressure gradient for blood flow in the heart.*
- *Atrioventricular and semilunar valves ensure unidirectional blood flow, by preventing it back-flowing.*
- *Septum completely separates oxygenated and deoxygenated blood*
    - *Tendinuous cords attached to atrioventricular valves prevent them being turned inside out.*

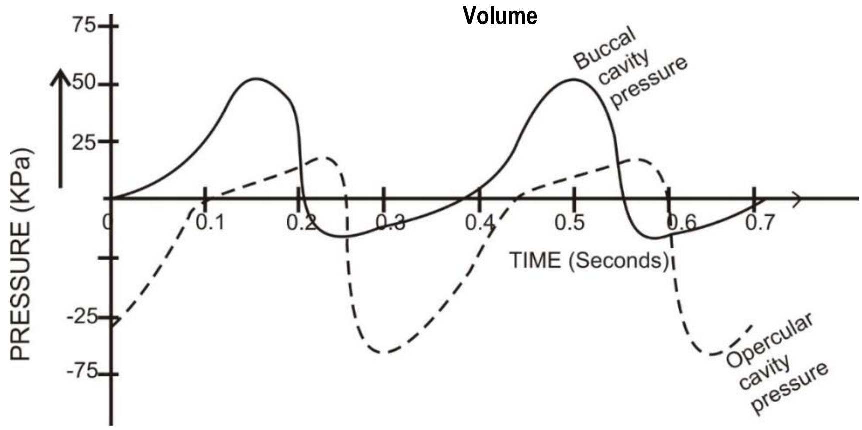
7. *An investigation was carried out into the relationship between the rate of water absorption and the rate of transpiration in sunflower plants at various times of the day. The results are shown in the diagram below:*



a) *i) Describe the changes in the rate of transpiration that took place during the experiment.*
   ii) Suggest why these changes occurred.
b) *Comment on the relationship between the rate of transpiration and the rate of water absorption during the experiment.*
c) *Why is transpiration a necessary evil?*
d) *Describe fully the passage of water from the soil to the xylem tissue of plant roots.*
e) *i) Explain why according to the pressure flow hypothesis, translocation can only take place in living phloem.*
   i) According to the pressure flow hypothesis, how do organic substances move in opposite directions in the phloem?

8. a) How is the Bohr Effect involved in the transportation and exchange of respiratory gases.
Describe how the rhythm of heart beat is initiated and controlled

9. The figure below shows the pressure changes in the buccal and opercular cavities of a teleost fish that were obtained using a hypodermic tubing connected to a pressure recorder:



The table below summarizes the features of gills in three species of teleost fish A, B and C:

Species of fish	***Thickness of Lamellae/ µm***	***Distance between Lamellae/ µm***	***Distance between blood and surrounding water/ µm***
A	*35*	*75*	*6*
B	*15*	*40*	*3*
B	*5*	*20*	*1*

Use the information in the figure and table to answer the following questions:

(a) *Compare the pressure changes in the bucccal cavity and opercular cavity in the first 0.4 seconds.*

(b) *Account for the observed changes in pressure in the buccal and opercular cavities from 0.2 seconds to 0.6 seconds.*

(c) *What is the physiological significance of the difference between the pressure in the buccal and opercula cavities.*

(d) *From the table explain how thickness of lamellae is related to the extent of activity of the fish.*

(e) *Blood in the Lamellae flows in opposite direction to that of the water. Comment on the efficiency of this mechanism of gaseous exchange.*

10. *(a) The table below shows the difference in percentage saturation of blood with oxygen at varying partial pressure of oxygen between a pregnant woman and that of a fetus developing in her uterus.*

Partial pressure of oxygen/mmHg	***Percentage saturation of blood with oxygen***	
	Mother	***Fetus***
1.3	*8*	*10*
2.7	*20*	*30*
3.9	*40*	*60*
5.3	*65*	*77*
6.6	*77*	*85*
8.0	*84*	*90*
9.3	*90*	*92*
10.6	*92*	*92*

(i) Plot the result in a suitable graphical form.

(ii) Compare the percentage saturation of blood for the mother and that of the fetus.

(iii) Suggest why the two curves plotted in (a) (i) are sigmoid.

Explain the physiological significance of the position of the fetal curve

11. In an investigation on transpiration, twelve twigs of approximately the same age, leaf surface area and from the same plant species were used in an experiment.

The twigs were divided into three group of four and each group treated simultaneously as follows:

Group 1: Twigs completely covered with transparent polythene bags.

Group 2: Twigs fanned with electric fans and Group 3: Twigs placed in still air in the open.

The table below gives a summary of the results of the mean values in cm^3 of four readings taken in each group represented on the table as A, B and C.

Time of day (hours)	***Mean readings (cm^3)***		
	A	***B***	***C***
08.00	2.0	2.0	2.0
09.00	3.0	2.4	2.5
10.00	4.2	2.6	3.4
11.00	5.4	2.7	4.4
12.00	7.1	2.8	5.5
13.00	9.6	2.9	7.0
14.00	13.1	2.9	9.5
15.00	16.6	2.9	11.5
16.00	18.1	2.9	13.0
17.00	19.0	3.0	13.6
18.00	19.5	3.1	13.9

a) Calculate the mean cumulative volume of water lost in each hour by the twigs of groups A and B and record them in an appropriate table.

b) Using suitable scales and the same axes, draw curves to show the relationship between:

i) The mean cumulative volume of water lost by the twigs of group A and B with time.

ii) The mean volume of water lost per hour by the twigs of group C with time.

c) From the curve drawn, identify the experimental condition to which each group of twigs A, B and C were placed.

d) With respect to twigs of A and B, give reasons for the observed differences in the two curves drawn.

e) Explain why the rate of water loss throughout the day varies as shown in curve C above.

f) Why were twigs of the same age, leaf surface area and same plant species used in the investigation.

g) Suggest:

i) a hypothesis which this experiment was designed to test.

ii) the name of the apparatus commonly used in this type of experiment

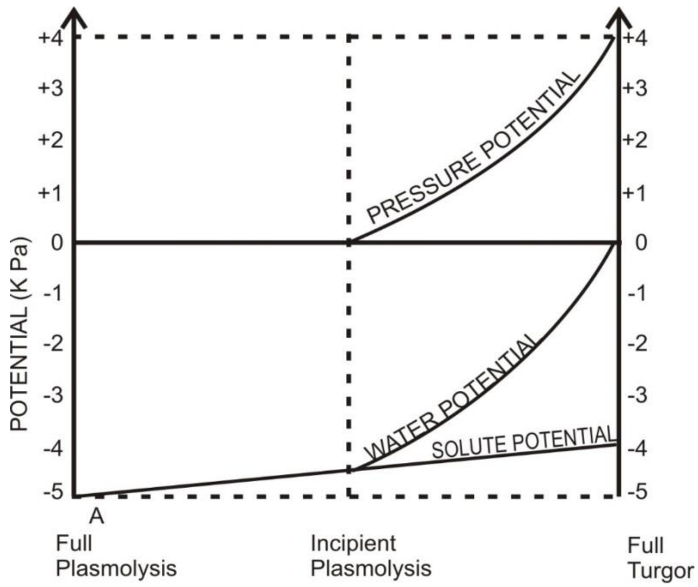
h) It is observed that a tree canopy with an area of $20m^2$ loses greater amount of water in a given length of time than a water body with the same surface area. Suggest an explanation for this observation.

12. a) What is lung ventilation?

b) Describe how lung ventilation and heart beat can be increased and lowered

13. a) Describe the structure of the dog fish gill
b) How does dog fish gill differ from that of the teleost fish?
c) Explain the mechanism of ventilation in the dog fish.

14. The graph below show changes in the different potentials of a fully plasmolysed plant cell in a hypotonic solution.



(a) Describe the shape of each of the following graphs:

(i) Pressure potential

(ii) Water potential

(iii) Solute potential

(b) Define each of the following terms:

(i) Water potential

(ii) Solute potential

(iii) Pressure potential

(c) Explain the shape of the graph of:

(i) Solute potential

(ii) Pressure potential

(iii) Water potential

(d) Define osmosis in terms of water potential.

(i) Explain why the osmotic potentials of solutions are always negative.

(e) i) Define the term active transport.

i) Describe the sodium-potassium as an example of active transport.

15. Mammalian red blood cells transferred from blood plasma to a less concentrated solution swell, and if they swell sufficiently, they burst; in which case they are said to have haemolysed. And when compared discs of potato tuber are placed in sucrose solutions of varying concentrations their mass changes. The table below shows the percentage of red blood cells haemolysed and the percentage change in mass of discs of tuber separately placed in a series of sucrose solutions ranging from 0.0 to 0.6M in covered dishes at a constant temperature of 20°C.

Concentration of sucrose solution (mol/dm^3)	**Percentage of red cells haemolysed**	**Percentage change in mass of potato tuber discs**
0.0	100	+22
0.1	90	+17
0.2	80	+9
0.3	68	+3
0.4	30	-3
0.5	16	-10
0.6	0	-15

a. Represent the information graphically using the same set of axes
b. From your graph determine:
   i) The sucrose concentration at which the proportion of haemolyzed to non-haemolyzed cells are equal.
   ii) The sucrose concentration that has an osmotic potential equal to the mean water potential of the cells of the potato tuber tissue.
c. Fully explain how you arrived at your answers in (b) (i) and (b) (ii)
d. Give an explanation of each of the following:
   i. Red blood cells placed in a 0.0M sucrose solution swell and burst while plant cells do not.
   ii. Red blood cells haemolyse over a range of sucrose solution concentrations rather than at one particular sucrose concentration.
   iii. Positive percentage changes in mass of potato tuber discs.
e. Suggest reasons why:
   i. The dishes containing the red blood cells or potato tuber discs are covered during the experiments.
   ii. The solutions are kept at a constant temperature of 20°C during the experiments.
   iii. The changes in mass of potato tuber discs are expressed as a percentage change.
f. Other than change in mass, briefly explain three other observable changes that are registered when potato tuber discs are treated with sucrose solutions of varying concentrations.

16. An investigation was carried out into the relationship between the rate of water absorption and the rate of transpiration in sunflower plants at various times of the day. The results are shown in the table below:

Time of day (hours)	**Rate of transpiration (gh^{-1})**	**Rate of water absorption (gh^{-1})**
08.00		10
10.00		32
12.00 (noon)		42

14.00		*51*
16.00		*42*
18.00		*32*
20.00		*08*
22.00		*05*
24.00 (midnight)		*07*
02.00		*06*
04.0		*07*
06.00		*06*

a) *Represent the information in the table graphically using a single set of axes.*
b) *i) Describe the changes in the rate of transpiration that took place.*
ii) Suggest why these changes occurred.
c) *Compare the two graphs.*
d) *i) What is the relationship between transpiration rate and rate of water absorption?*
i) Explain the relationship you have given in (d) (i) above.

ii) Explain how water moves from the soil into the xylem of the root.

e) *Explain how water moves through the xylem in the stem of a plant.*

16. Discuss the adaptations of plants and mammals to reduce water loss in extreme dry conditions. ***(20 marks)***

SOLUTION

16. Adaptations of plants to reduce water loss in extreme dry conditions.

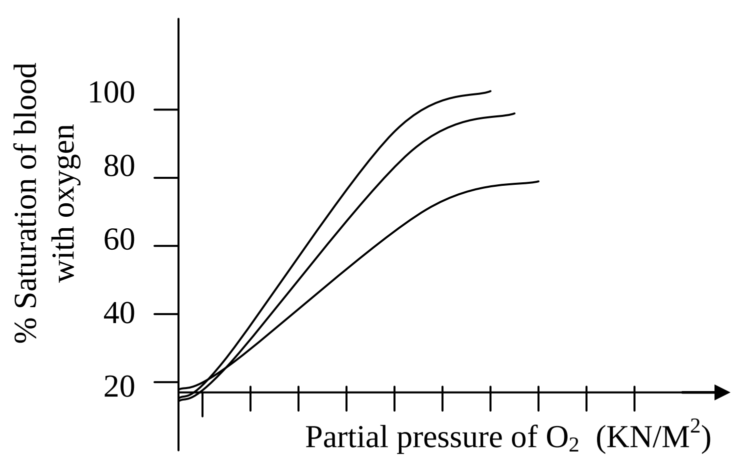
- *Possession of a thick waxy cuticle ,which serves as a waxy water-proof barrier that reduces cuticular transpiration, as in* ***Opuntia.***
- *Reduction of the number of stomata, which reduces stomatal transpiration, as in* ***Opuntia.***
- *Stomata are depressed, and sunk into pits, lengthening the diffusion path by trapping still moist air above the stomata, so reducing transpiration, as in* ***Amnophila,*** *pine, holly.*
- *Leaf surface covered with a protective layer of numerous fine hairs/ pubescence, which trap moist air, and lengthen the diffusion path, so reducing transpiration, as in ling,* ***Amnophila.***
- *Rolling leaves in to cylinders, to trap moist air within the leaf, and preventing water vapour diffusing out through the stomata ,which are then confined to the inner surface, as in* ***Amnophila.***
- *Reduction of leaves into spines or needles, reducing the surface area over which transpiration occurs, as in cacti, barberry, spurges.*
- *Leaves may be succulent, or small and circular, to reduce the surface area to volume ratio for gaining heat and losing water vapour, and so reduce transpiration, as in pine.*
- *Total absence of leaves, which limits water loss to stems that have fewer stomata, hence reducing transpiration, as in most cacti.*
- *An upper epidermis with very few or no stomata, with the lower epidermis having more stomata - hidden away from the warming effect of the Sun, to reduce transpiration, as in oak, apple.*

Adaptations of mammals to reduce water loss in extreme dry conditions.

- *Bergman's rule; Small size to reduce surface area for gaining heat and losing water by evaporation, as in* ***Dipodomys.***
- *Bipedal gait/ walking on two feet, to reduce heat gain through contact with hot sand during day, as in* ***Dipodomys****/Kangaroo rat.*

- *Extra-long loop of Henle in the kidneys, coupled with anomalously high levels of Antidiuretic hormone/ADH in the blood, to increase water reabsorption from the glomerular filtrate, and reduce excretory water losses, as in the camel.*
- *Tissues highly tolerant to high temperatures, allowing the mammal to let its temperature rise to even 41^{0}C. This partial ectothermy reduces water loss through sweating by reducing the temperature gradient between the animal and its surroundings, as in the camel.*
- *Possession of fur which insulates the body against heat gain, thereby reducing evaporatory water loss, as in camels.*
- *Small mammals pass the hot desert days in their burrows to avoid heat gain, and reduce water loss, as in* ***Dipodomys****.*
- *Cornified epithelium serves as a waterproof integument, reducing evaporatory water loss, as in camels.*
- *Oily skin secretions serve as a waterproof, reducing evaporatory water loss, as in the camel.*
- *Viviparity ensures that the embryo is protected from desiccation, and nourished within the uterus, as in camels.*
- *Countercurrent heat exchange; As air is inhaled it gains heat from the nasal passages which are cooled as a result. During exhalation water vapour condenses on the cool nasal passages, reducing respiratory water loss from the lungs, as in camels.*
- *Reduced number of kidney nephrons, to reduce excretory water los, as in camels.*
- *High urea concentration in the blood, aiding absorption of water from kidney tubules, as in camels.*
- *Reduced sweating, to reduces evaporatory water loss, as in the camel*
- *High rectal water reabsorption, producing hard dry faeces, reducing defaecatory water loss, as in camels.*
- *Slit-like, closable nostrils, guarded by dense hairs, to prevent evaporatory water loss during breathing, as in camels.*
- *Light skin/fur colour reduces heat absorption, to reduce evaporatory water loss, as in camels.*

17. *The above graphs show the haemoglobin oxygen dissociation curves of different mammals.*



a) Explain the shape of the curves.

b) *Explain why the oxygen dissociation curve of*

i) *a mouse is to the right of that of man.*

ii) *a lamma is to the left of that of man.*

c) *Suggest three adjustments which occur in the physiology of people who live at high altitude.*

*i)*____

*ii)*____

*iii)*____

19\. . a) *Define pressure potential.* *(2marks)*

----

b) *What will happen if an animal cell such as an erythrocyte is put in the following solutions?*

i. *A solution whose water potential is less negative than that of the animal cell.* *(2marks)*

----

ii) *A solution whose water potential is more negative than that of the animal cell.* *(2marks)*

----

c) *Why would the observation in b(i) above change if a plant cell is used.*

-- *(6marks)*

d) *Name two factors necessary for osmosis.* *(2marks)*

20\. a) *What is mass flow in relation to transport in plants.*

……………………………………………………………………………………

b) *State three conditions under which mass flow may occur.*

……………………………………………………………………………………

c) *Give two differences between mass flow and cytopasmic streaming.*

……………………………………………………………………………………

21\. . a) *Define the term 'cardiac cycle'.* *(2marks)*

……………………………………………………………………………………

b) *Describe the cardiac cycle in mammals.* *(8marks)*

……………………………………………………………………………………

22\. . a) *What is mass flow in relation to transport in plants.*

……………………………………………………………………………………

c) *State three conditions under which mass flow may occur.*

……………………………………………………………………………………

c) *Give two differences between mass flow and cytopasmic streaming.*

……………………………………………………………………………………

23\. a) *Define the term 'cardiac cycle'.* *(2marks)*

……………………………………………………………………………………

b) *Describe the cardiac cycle in mammals.* *(8marks)*

……………………………………………………………………………………

24. a) *Define the following terms related to water movements in plant cells.*

i) water potential. (1mark)

…………………………………………………………………………………………

…………………………………………………………………………………………

ii) Osmotic potential / solute potential. (1mark)

iii) Turgor pressure (1mark)

iv) Pressure potential (1mark)

…………………………………………………………………………………………

b) *The figure 2 better shows a plant cell immersed in sucrose solution. The pressure potential (ψ_p) of the cell, osmotic potential of the cell (ψ_{3cell}) and the osmotic potential of the solution ψ_s (solution) are shown in the diagram.*

ψ_P = 350KPa

$\psi_{s(cell)}$ = -800KPa

ψ_s(solution) = -1500KPa.

i) Calculate the water potential (ψ cell) of the cell above. Show your working. (12marks)

…………………………………………………………………………………………

ii) *State whether water will move into or out of the cell and give a reason why. (2marks)*

…………………………………………………………………………………………

c) *Explain why a plant cell placed in distilled water does not but, yet mammalian red blood cell burst. (2marks)*

…………………………………………………………………………………………

25. a) *What is a closed circulatory system? (1mark)*

………………………………………………………………………………………..

b) *How is blood flow maintained in such a system? (5marks)*

………………………………………………………………………………………..

c) *Give three ways in which the circulatory system of an earthworm is similar to that of man. (3marks)*

i)………………………………………………………………………………..

ii)……………………………………………………………………………..

iii)……………………………………………………………………………..

26. a) *Distinguish the following terms:*

i) Water potential and solute potential. (2marks)

…………………………………………………………………………………………

ii) Incipient plasmolysis and turgor pressure. (2marks)

…………………………………………………………………………………………

iii) Osmosis and diffusion (2marks)

…………………………………………………………………………………………

b) *Considering the two adjacent plant cells A and B shown below*

i) Which of the ***two*** *cells has a higher water potential. (1mark)*

…………………………………………………………………………………………

ii) State the direction in which water will move by osmosis?(1mks)

…………………………………………………………………………………………

iii) Give a reason for your answer in b(ii) above. (1 ½ marks)

…………………………………………………………………………………………

c) *In an experiment set up to determine the water potential of plant cells using potato cylinders in a range of sucrose solution the following data was obtained.*

Sucrose concentration	Mean % change in mass

0.0M	*+22*
0.1M	*+17*
0.2M	*+9*
0.3M	*+3*
0.4M	*-3*
0.5M	*-10*
0.6M	*-15*

i) Plot the figures on graph paper. (6 ½ marks)
ii) Using the graph you have plotted, what concentration of sucrose solution has an osmotic potential equal to the water potential of the tissue used. (1mark)

………………………………………………………………………………………

iii) What substance would have a sucrose concentration. (1mark)

………………………………………………………………………………………

27. a) What is mass flow in relation to transport in plants? (3marks)

……………………………………………………………………………………...

b) State three conditions under which mass flow may occur? (3marks)

……………………………………………………………………………………...

c) Give two differences between mass flow and cytoplasmic steaming. (2marks)

……………………………………………………………………………………...

28. a) Distinguish the following terms:
i) Water potential and solute potential. (2marks)
ii) Incipient plasmolysis and turgor pressure. (2marks)
iii) Osmosis and diffusion (2marks)
B Considering the two adjacent plant cells A and B shown below
*i) Which of the **two** cells has a higher water potential? (1mark)*
II) State the direction in which water will move by osmosis?(1mark)
iii) Give a reason for your answer in b(ii) above. (1 ½ marks)

c) In an experiment set up to determine the water potential of plant cells using potato cylinders in a range of sucrose solution the following data was obtained.

Mean % change in mass	*Sucrose concentration*
+22	*0.0M*
+17	*0.1M*
+9	*0.2M*
+3	*0.3M*
-3	*0.4M*
-10	*0.5M*
-15	*0.6M*

i) Plot the figures on graph paper. (6 ½ marks)
ii) Using the graph you have plotted, what concentration of sucrose solution has an osmotic potential equal to the water potential of the tissue used. (1mark)
iii) What substance would have a sucrose concentration? (1mark)

29. Outline the events in the following transition
a) Turgi plant cell to plasmolysed plant cell. Diagrams are not needed. (5marks)

b) Golgi vesicle to residual body. (Diagrams are not needed)

30. a) Define pressure potential. (2mks)

b) What will happen if an animal cell such as an erythrocyte is put in the following solutions?

i) A solution whose water potential is less negative than that of the animal cell.(2 marks)

ii) A solution whose water potential is more negative than that of the animal cell.(2marks)

b) Why would the observation in b(i) above change if a parenchyma cell is used.(2mks)

c) Name two factors necessary for osmosis. (2marks)

31. a) Fill in the gaps with the most appropriate word or words to complete the passage. (**4 ½ marks**)

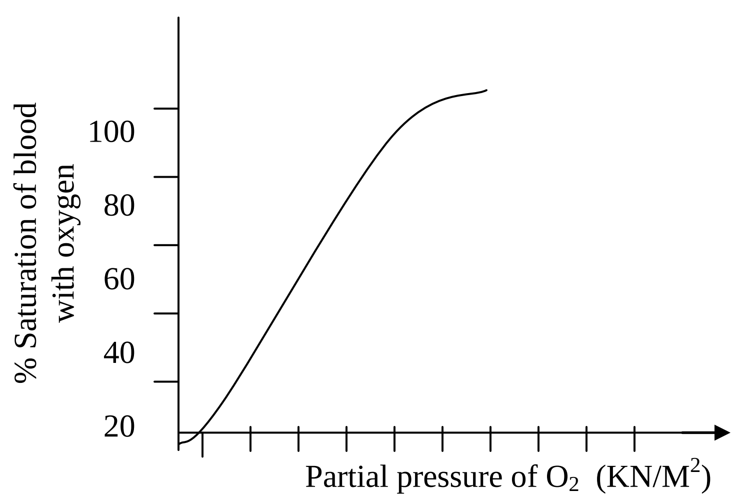
When a cell is plasmolysed, pressure potential is ………., water potential of a cell is equal to ………..and the cell is said to be ………If this cell is placed in pure water , its water potential is ………than that of the external medium so water ……..by osmosis.

The water potential becomes …... until the cell becomes…… At this point, osmotic potential and pressure potential are……but ……………..

b) Explain why water is liquid at room temperature, yet substances with similar molecular mass eg NH_3 (17), CH_4 (17) are gases at room temperature. (**3marks**)

c) Account for the high heat of vapourisation of water an give one significance of it in human beings. (**1 ½ marks**)

32. The figure below is the oxygen dissociation curve for haemoglobin sharing how the amount of oxygen in man is related to his oxygen pressure.



a) On the figure above, draw the appropriate positions of dissociation curves for:

(i) The South American Illama of the Andes mountain (2 marks)

(ii) A camel (2 marks)

b) Explain briefly why in your view, the curves should be where you have drawn them with respect to that of man.

Illama (3 marks)

Camel (3 marks)

33. a) *Distinguish between the following pairs of terms.*

i) *blood and lymph* (2marks)

ii) *plasma and tissue fluid.* (2marks)

b) *A fish such as a trout has a single circulation while a mammal has a double circulation.*

i. *Explain one advantage of a double circulation.* (2marks)

i. *The table below shows how a certain factors which affect the supply of oxygen to the tissues of a throut increase during maximum activity.*

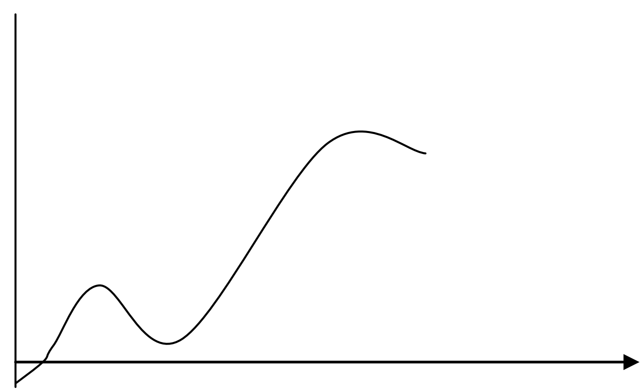
Factor	Number of times factor is increased from resting level
Heart rate	1.36
Heart stroke	2.24
0_2 released by haemoglobin	2.66

Suggest how the nervous system might produce the change in heat rate shown in the table. (2marks

iii. *What is meant by stroke volume?* (1mark)

iv. *How is stroke volume related to cardiac output?* (2marks)

34. *The fig. below shows the immune response of a person's blood after Vaccinations are given on day one and 60 days later.*



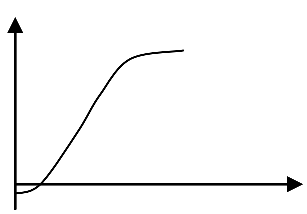
a) *What is the effect of giving immunization to the individual?*(1mark)

b) *From the graph, state the type of immunity acquired by the individual giving a reason.* (2marks)

c) *Explain the shape of the graph.* (4marks)

d) *Describe three ways in which antibodies combat antigens.*(3mks)

35. *The fig. below shows the variation of percentage saturation of haemoglobin with oxygen as the hydrogen ion concentration of a respiring tissue changes.*



Concentration of hydrogen ions

a) *Explain the graph.* (4marks)

b) Use a broken line to draw a curve on the above fig. that would be obtained if the rate of respiration is increased. (1mark)

c) Explain the curve obtained in (b) above . (5marks)

36. a) Explain how an increase in the solute potential of a plant cell affects it's
    i) Turgidity . (2marks)
    ii) Pressure potential. (2marks)

b) How do terrestrial plants take up mineral salts from the soil to the leaves (6marks)

37. a) Define the term counter current multiplier.

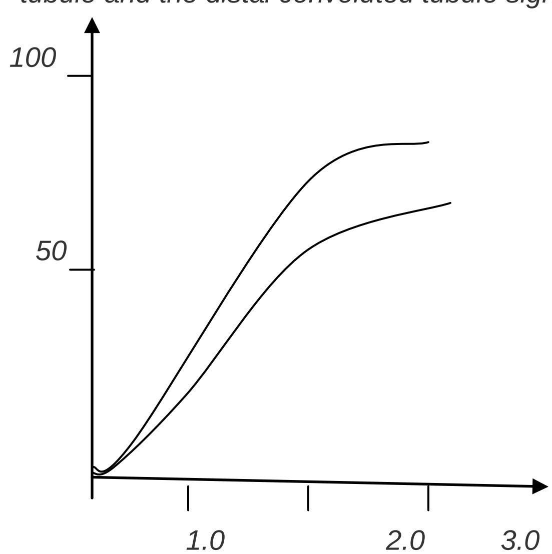
b) Outline any four features which favour the loop of Henle to serve as a counter current multiplier
    i) ……………………………………………………………………………
    ii) ……………………………………………………………………
    iii) ……………………………………………………………………………
    iv)………………………………………………………………………….....

c) Study the sketch graph below and answer the questions which follow

i) What does the ratio 1.0 signify?

ii) Account for the changes in renal to plasma ratio of the following at the proximal tubule;
Chloride ions
Glucose of treated kidney
Glucose of non treated kidney

b) What does the difference between the ratio of chloride ions at the proximal tubule and the distal convoluted tubule signify?



a) Describe the partial pressure of oxygen in water for the
    i. Carp (3marks)
    ii. Mackerel (4marks)

b) Explain how the oxygen dissociation curve of
    i. Carp haemoglobin is related to the fact that carp may be found in pods containing large amounts of decomposing vegetation. (2marks)
    ii. Mackerel haemoglobin is related to the fact that the Mackerel is a very active species found in the surface waters of the sea.(2marks)

c) Both of these fish have a single circulation.
    i. Explain what is meant by a single circulation. (1mark)

ii. *Give two advantages of a double circulatory system as compared to a single circulatory system. (2marks)*

38. (a) Discuss the advantages of possessing membrane –bound organelles in a eukaryotic cell. (10 marks)
(b) How does the structure of a nucleus compare with that of a mitochondrion? (10 marks)

39. (a) Explain the adaptations of the chloroplast to its functions. (08 marks)

40. Discuss the distribution and functions of membranes of eukaryotic cells.(20 marks)

SOLUTIONS
38. (a) Advantages of possessing membrane –bound organelles in a eukaryotic cell

- *Increases proportion of membrane area to cell volume increasing surface area over which metabolic reactions occur, for metabolic pathways with membrane –embedded enzymes.*
- *Internal membranes partition the cell into compartments, providing different local environments for specific metabolic pathways so that incompatible processes can proceed simultaneously inside the same cell.*
- *Inner membranes provide attachment sites for specific enzymes metabolites and molecules regulating the occurrence of specific metabolic processes.*
- *Enzymes and metabolites for particular metabolic pathways are enclosed within organelles enabling close proximity of products of one reaction to the next enzymes in the sequence thereby increasing the rate of metabolic reactions.*
- *Internal membranes regulate the entry of metabolites into the organelles controlling the rate of metabolic activity.*
- *Potentially harmful metabolites and enzymes are isolated inside organelles preventing damage to the rest of the cell for example lytic enzymes in lysosomes.*
- *Internal membranes provide a supporting cytoplasm to the cell and serve as an intracellular transport system.*
- *Internal membranes protect the genetic material/ DNA from digestion and chemical alternation , preventing harmful mutation*

. (b) Comparison of structure of nucleus and mitochondria
SIMILARITIES

- *Both contain DNA*
- *Both contain RNA*
- *Both contain ribosomes*
- *Both are enclosed by a double membrane*
- *Both contain enzymes*

DIFFERENCES

NUCLEUS	***MITOCHONDRION***
Linear DNA	*Circular DNA*
DNA contained in chromosomes	*DNA not contained in chromosomes*
Larger 80S ribosomes	*Smaller 70S ribosomes*
Membrane has pores	*Membrane has no pores*

Inner membrane not folded	*Inner membrane folded to form critae*
Over-shaped or spherical	*Sausage –shaped , spiral or cup-shaped*
Outer membrane continuous with endoplasmic reticulum	*Outer membrane not continuous with any organelles*
Ribosomes may be attached on outer membrane.	*Ribosomes not attached on outer membrane.*

SOLUTION

39. (a) Adaptations of the chloroplast to its functions

- *Chloroplasts within the mesophyll cells can move towards light, arranging themselves in the best position within the cells for maximum absorption of light.*
- *Bound by a double membrane to isolate the photosynthetic reactions from other cell activities.*

- *Contains numerous closed, flattened , fluid filled sacs called thylakoids to hold chlorophyll and accessory pigments in a structured way in a suitable position to trap maximum light.*
- *Thylakoids are stacked on top of each other forming grana, interconnected by lamellae to provide a large surface area within the small volume for maximum light absorption.*
- *Lamellae are suspended in a water matrix/ strama containing enzymes for the reduction of carbon dioxide and other chemicals essential in the photosynthetic pathways and for the storage of the end –products of photosynthesis.*
- *Chloroplast is transparent due to the thin envelope and the colourless stroma allowing maximum absorption of light by photosynthetic pigments.*
- *Stroma serves as a site for the light independence reaction of photosynthesis.*
- *Arrangement of chlorophyll in the thylakoids brings it into close proximity to other molecules necessary for its functioning in light harvesting photo systems.*
- *Inner membrane of envelope is highly selective in what it allows in and out of the chloroplasts, regulating the conditions of the internal chloroplast environment for optimum rate of photosynthesis.*

40. Distribution and functions of membranes of eukaryotic cells.

DISTRIBUTION	***FUNCTIONS***
Cell surface membrane surrounds the protoplasm	*Partial permeability encloses protoplasm . allows exchange of materials, cell to cell recognition .* *Reception of chemical signals such as hormones , sticking correct cells together in tissue formation may contain enzymes, energy transducers ,electron carries.*
Nuclear membrane bouds the nucleus nucleoplasm	*Outer membrane covered with ribosomes for protein synthesis inner membrane has achering point for chromosomes during interphase, nuclear pores allow exchange of materials between nucleus and cytoplasm allows mRNA out, limits DNA.*
Mitochondrial envelope bounds the mitonchondrion	*Outer mitochondrial membrane selectively permeable to chemicals .* *Inner mitochondrial membrane is site for attachment of components of respiratory*

DISTRIBUTION	*FUNCTIONS*
	chain.
Endoplasmic reticulum runs throughout the cytoplasm as extension of outer nucleus membrane	*Provides large surface area for biochemical reactions pathway for intercellular transport. RER is site for attachment of ribosome, synthesis of proteins, lipids and carbohydrates, storage of lipids and carbohydrates, SER of liver dells contains lytic enzymes.*
Chloroplast	*Outer chloroplast envelop allows*
Photosynthetic membranes form thylakoids grana and lamellae found in chloroplasts	*Contain photosynthetic pigment enzymes and electron can for photosynthesis*
Membraneous cisternae and golgi vesicles of golgi apparatus	*Sorting ER-synthesized mate synthesis of glycoprotein , enzymes and polysaccharides of glycoprotein and lipids forms of lysosomes , transporting lipid*
Single membrane bounds lysosomes	*Limit autolytic enzymes autolysis*
Tonoplast bounds plant cell vacuoles	*Limits call sap selectively allowing osmosis in out of vacuole.*
Single membrane bounds phagocytic vesicles	*Uptake of bulk solid material*
Single membrane bounds peroxisomes/ microbodies	*Limit enzymes such as*
Myelin sheath membrane bounds mylinated exons	*Insulation of nerve fibre.*

41. *(a) Describe the fluid-mosaic model of the cell membrane (10marks)*
(b) How does this model in (a) compare to the Davson-Danielli model (10marks)

SOLUTION

41. (a) The fluid-mosaic model of cell membrane

- *Proposed by J.J singer and G.L Nicholson in 1972.*
- *Consists of a bimolecular phospholipid layer with inwardly directed hydrophilic heads and a variety of irregularly arranged proteins.*
- *Each phospholipid consists of a polar hydrophilic head containing phosphate and two non-polar hydrophobic hydrocarbon tails*
- *Proteins may be peripheral/extrinsic occurring on the surface of the phospholipid layer integral/ intrinsic extending into the phospholipid layer or trensmembrane extending completely across the membrane.*
- *Also contains glycoprotein glycolipids and cholesterol*
- *Glycoprotein consist of an outward branching carbohydrate portion combined with a globular protein*
- *Glycolipids consists of a branching carbohydrate portion attached to a phospholipid*
- *Phospliolipid layer is capable of much movement and is therefore fluid*
- *Proteins are dotted throughout the biphospholipid layer in a mosaic pattern*

(b) Comparison of fluid-mosaic and Davson-Daniell models of cell membrane

Similarities

- *Both comprise a bimolecular layer of phospholipid*
- *Both contain protein molecules*
- *In both phospholipids possess hydrophilic heads and hydrophobic tails*
- *In both the phospholipid tails extend inwards, while the heads lie at the peripherical*
- *Both comprise a main structural skeleton lipids and proteins*

Differences

Fluid- mosaic model	***Davson-Daniell model***
Proteins arranged irregularly in a mosaic pattern	*Proteins arranged regularly*
Proteins may lie on the surface, extend in to the lipid layer, or extend right through it.	*Protein only lie the surface*
Lipids $ proteins capable of much fluid movement	*Lipids & proteins via and cannot move*
Protein molecules are of different sizes	*Protein molecules a of the same size*
Some proteins have pores	*Proteins lack pores*
Proteins may be structured carriers, channel or enzymes	*Proteins are only structural*

42 . How are the following structures suited to their functions?

(a) Plant cell wall

(b) Cell surface membrane

SOLUTION

42. (a)Adaptations of plant cell wall

- *Extensive lignifications provide mechanical strength and skeletal support to the cell and plant as a whole*
- *Rigid and resistant to expansion allows build up of turgidity offering mechanical support in herbaceous plants and structures.*
- *Rigid cell wall prevents cell bursting due to osmotic influx of water from hypotonic solution*
- *Orientation of cellulose microfibrils limits and controls cell growth and shape*
- *Interconnected cell awls forms apoplast a major pathway of movement for water and dissolved mineral salts.*
- *Cell wall has minute pores through which plasmodesmata pass allowing all protoplasts to be liked in a system called the symplast for exchange of materials between adjacent cells*
- *Cell walls of root endodermal cells are impregnated with suberin forming a water barrier called the casparian strip. This concentrates movement of water through special passage cells and controls movement of solves through root xylem*

- *Cell walls of transfer cells develop increased surface area to increase efficiency of transfer by active transport.*
- *Cell walls xylem are lignified making the walk impermeable to water and solutes thus preventing leakage of contents during transport*
- *Lignifications of xylem cell walls gives them high tensile strength preventing collapsing when conducting water under high tension*
- *Impregnation of xylem cell walls with lignin increases adhesion of water molecules; this helps water to rise by capillarity in an unbroken column.*
- *Deposition of cutin in the matrix of cell walls of the leaf epidermis forms a waxy cuticle this reduces water loss and risk of infection*
- *Cell walls impregnated with hemicelluloses are modified for food storage in some seeds*
- *Lignified xylem walls primary cell wall only these permit lateral flow of water in and out of the lumen where necessary.*

(b)Adaptations of the cell surface membrane

- *Phospholipid molecules give the membrane fluidity*
- *Arrangement of non-polar hydrophobic tails and polar hydrophilic head of phospholipids affects permeability making the membrane selectively permeable*
- *Cholesterol disturbs close-packing of phospholipids making membranes less fluid at higher temperatures and more fluid at lower ones.*
- *Cholesterol is non-polar thus reduces escape or entry of polar molecules through the membrane*
- *Membrane cholesterol increases flexibility and stability of the membrane prevent membranes breaking up.*
- *Carbohydrates side chains of glycolipids act as antennae marking specific cells, this enables cell-cell recognition as in the ABO blood system.*
- *Glycolipids act as receptor sites for decimal signals such as hormones*
- *Glycolipids and glycoprotein are involved in sticking the correct cells together in tissues*
- *Channel proteins and carrier proteins transport polar substances across the membrane through facilitated diffusion and active transport*
- *Some membrane proteins act as enzymes making the membrane metabolically active*
- *Some membrane proteins act as receptor sites for body chemical signals like hormones and neurotransmitters during coordination*

- *Some proteins act as energy transducers and electron carriers enabling energy transfer in photosynthesis/diboroplasts and respiration/mitochondria*

- *Proteins dotted throughout the biphospholipid layer provide structural support to the cell membrane.*

- *Carbohydrate side chains of glycoproteins act as cell-marking antennae enabling cell-cell recognition during tissue development.*

- *Glycoprotein act as antigeus enabling recognition of foreign outigeus during immune responses*

- *Glycoproteins act as receptor sites for chemical signals such as hormones and neurotransmitters during nervous and hormonal coordination.*

- *Cell membrane is very thin (approx 7 mm) for fast diffusion of materials across*

43. (a) with an example in each case briefly describe the four nutritional categories of bacteria

(12 marks)

(c) How does a bacterial cell differ from that of a higher plant (08 marks)

SOLUTION

43. (a)The four nutritional categories of bacteria;

- *, parasites, mutualistPhotoautotrophic bacteria use an inorganic source of carbon/carbon dioxide is source of carbon obtain their energy from light examples blue-green bacteria/Anabaena/Spirulina/Spirogyral/Chlorella (green bacteria, blue-green bacteria, purple sulphur bacterial, purple non-sulphur bacteria.*

- *Photoheterotrophic bacteria use an organic source of carbon/carbonhydrate is source of carbon obtain their energy from light examples purple non-sulphur bacteria*

- *Chemoautotrophic bacteria use an inorganic source of carbon/carbon dioxide is source of carbon obtain their energy from chemical reactions/oxidation of inorganic materials such as ammonia, nitrites examples nitrifying bacteria/Nitrosomonas/ Nitrobacter sulphur bacteria.*

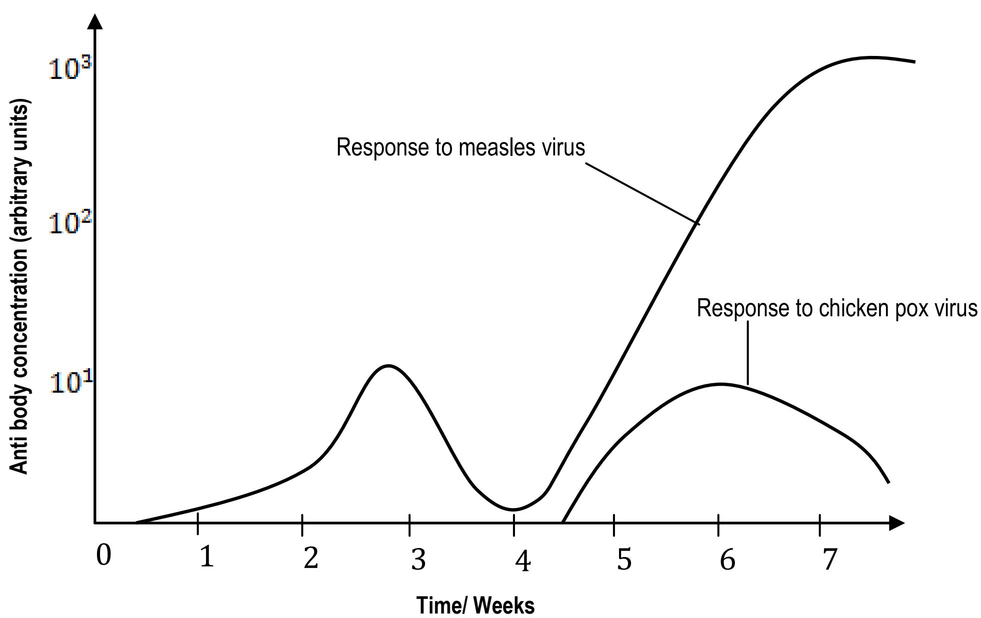
- *Chemoheterotrophic bacteria use an organic source of carbon obtain their energy from chemical reactions/oxidation of organic food materials examples saprotrophs/ decomposers/ mutualistic bacteria/parasitic bacterial/ Rhizobium, Escherichia, coli (saprotroplus).*

b) Differences between a bacterial cell and a higher plant cell

Bacterial cell	*Higher plant cell*
Has no distinct / true nucleus.	*Has distinct/ true nucleus.*
DNA not incorporated; in chromosomes	*DNA incorporated in chromosomes*
DNA is circular;	*DNA is linear*
No spindle is formed; during cell division	*A Spindle Is Formed during cell division*
Few organelles;	*Many organelles*
Lack of organelles surrounded by two membranes/ envelope;	*Has organelles surrounded by two membranes/envelope e.g. mitochondria, chloroplasts*

Cell wall made of amino acids & polysaccharides strengthened by murein;	*Cell wall made of polysaccharides strengthened by cellulose.*
Smaller coverage (diameter 0.5-10mm);	*Lager (average diameter 10-100mm)*
No chloroplast. Photosynthesis occurs on unstacked membranes;	*Has chloroplast containing membrane stacked into lamellae or grana*
Some can fix nitrogen;	*None can fix nitrogen*
Respiration occurs on mesosomes in bacteria, and eytoplasmic membranes in blue - green bacteria;	*Aerobic respiration occurs in mitochondria and anaerobic respiration occurs in cytoplasm*
Some have flagella;	*None has flagella*
Has smaller (705 ribosomes)	*Has larger(805 ribosomes)*
Divide binary fission mostly	*1divde by mitosis, meiosis or both*

44. *The concentration of antibodies of a child was measured over a period of eight weeks. The child was exposed to the measles virus at a time 0 weeks when he inhaled droplets from the infected person. At the fourth week, the child was exposed to the measles virus, and at the same time, he was exposed to chicken pox virus. The results are shown in the graph below.*



Use the information provided to answer the questions that follow.

a) *Compare the variation in concentration of antibodies during the first and the second exposure to the measles virus.*

b) *Account for the differences in (a) above.*

c) *Using the results above, suggest why;*

   (i) *Children who catch measles for the first time suffer symptoms of the disease, but normally recover completely within two to three weeks of being infected.*

   (ii) *A person who has had measles normally is immune for life.*

   (iii) *A person with measles is mostly infectious about 8-16 days after first infection.*

d) *How do the results of this study illustrate that the immune response is specific?*

e) *State with reasons the type of immunity illustrated.*

f) How have the results of this study been applied by humans in the prevention and control of certain human disease?

g) *Certain plants called Cyanogenic plants use hydrogen cyanide as a defense mechanism against herbivores. The table below shows the average cyanide content of leaves of certain plants of different ages.*

Age of leaf (weeks)	***Average cyanide content of leaf (mg/100g by weight)***
1	*9.9*
3	*4.3*
5	*2.1*
7	*1.0*
9	*0.5*
11	*0.2*
15	*0.0*

(i) *Present the information in the table above graphically.*

(ii) *State the relationship that exists between cyanide concentration and age of the leaf.*

(iii) *In what way could this relationship be of survival value to the plant?*

Suggest any other defense mechanisms used by plants