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A' Level Biology Seminar

Proposed answers to selected questions

At Makerere University

On Sunday 24th September, 2023

NUTRITION

22. In an experiment to determine factors affecting photosynthesis, seedlings of a plant were divided into two groups and grown under different light intensities. One group of seedlings was grown at constant high light intensity (25 arbitrary units), and another group grown at a constant low light intensity (3 arbitrary units). When the plants were mature, their apparent rates of photosynthesis n milligrams of oxygen released per unit leaf area per hour, were measured over a range of different light intensities. Fig.1 shows the results of the experiment. In addition, some characteristics of the two groups of plants were recorded as indicated in table 1.

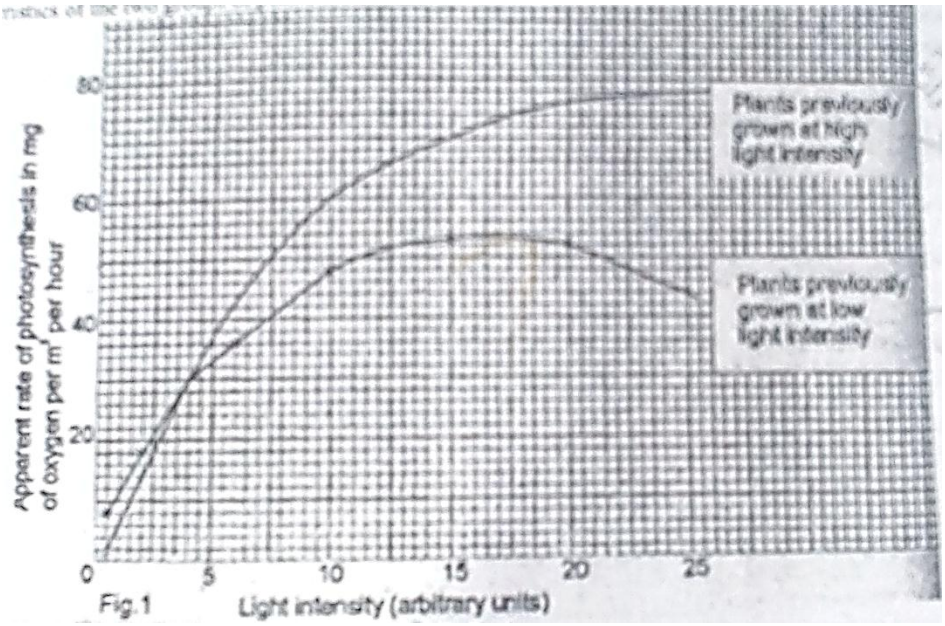


Fig.1

Table 1

Group of plants	**Characteristics**
Plants grown at high light intensity	**Big, dark green leaves with short internodes**
Plants grown low light intensity	**Small, pale yellow leaves with long internodes**

a) From the graph, state the:

(i) differences in the effect of light intensity on the two groups of plants (08 marks)

Plants grown at high light intensity	Plants grown at low light intensity
At light intensity less than 4 arbitrary units, rate of photosynthesis is lower	At the same light intensity, rate of photosynthesis is higher
At light intensity above 4 arbitrary units, rate of photosynthesis is higher	At the same light intensity, rate of photosynthesis is lower
Maximum rate of photosynthesis is higher	Maximum rate of photosynthesis is lower
Maximum rate of photosynthesis is attained at a higher light intensity	Maximum rate of photosynthesis is attained at a lower light intensity
Rate of photosynthesis attained a maximum then remained almost constant/ maintained	Rate of photosynthesis attained a maximum and then declined
At 15 arbitrary units of light intensity, rate of	At the same intensity, rate of photosynthesis

photosynthesis was still increasing	attained a maximum
Initial rate of photosynthesis is lower	Initial rate of photosynthesis is higher
At 24 units of light intensity, rate of photosynthesis was at maximum which was maintained	At the same light intensity and beyond, rate of photosynthesis had declined.

(ii) Similarities in the effect of light intensity on the two groups of plants. (03 marks)

- Rate of photosynthesis in both groups of plants increases with increase in light intensity (limiting factor); but up to a certain point/ quantity of light intensity.
- At 4 arbitrary units, both groups of plants have equal/ same rate of photosynthesis.
- Rate of photosynthesis started at 0.5 arbitrary units of light intensity.

b) Suggest explanations for the differences you have stated in a(ii) above. (08 marks)

At light intensity less than 4 arbitrary units, rate of photosynthesis is higher in plants grown at low light intensity because photosynthesis enzymes are more activated than those in plants grown at light intensity.

At light intensity above 4 arbitrary units, photosynthesis enzymes in plants grown in higher light intensity are activated; because these plants have better/ greater ability/ more adapted to utilize bright light. Maximum rate of photosynthesis in plants grown in lower light intensity is lower because their metabolic requirements are lower, than those in plants grown in higher light intensity.

c) Explain the pattern of the curve for plants grown in low light intensity. (06 marks)

The rate of photosynthesis increases with increase in light intensity because light is the limiting factor up to 15 arbitrary units of light intensity. Between 15 to 18 arbitrary units of light intensity, the rate of photosynthesis is constant; because the saturation point/ maximum under this condition has been reached/ other factors other than light begin limiting the rate of photosynthesis. Beyond 18 arbitrary units, the rate of photosynthesis begins to fall because light intensity is affecting photosynthesis negatively; bleaching chlorophyll.

d) Explain the observed characteristics of the two groups of plants as shown in Table 1. (09 marks)

Leaf color

Strong light stimulates production of chlorophyll than weak light intensity; hence more chlorophyll in plants grown in higher light intensity than those growth in low light intensity.

Internode length

Internode is longer in low light intensity because of etiolation/ competition for light. In higher light intensity, the internode is shorter due to less etiolation/ lack of competition for light.

Leaf size

Bigger size in higher light intensity is because of production of enough carbohydrates due to a higher rate of photosynthesis.

e) Suggest why:

(i) Seedlings of the same plant were used in the experiment. (02 marks)

To ensure uniformity/accuracy in the results; and avoid other factors that could affect the rate of photosynthesis.

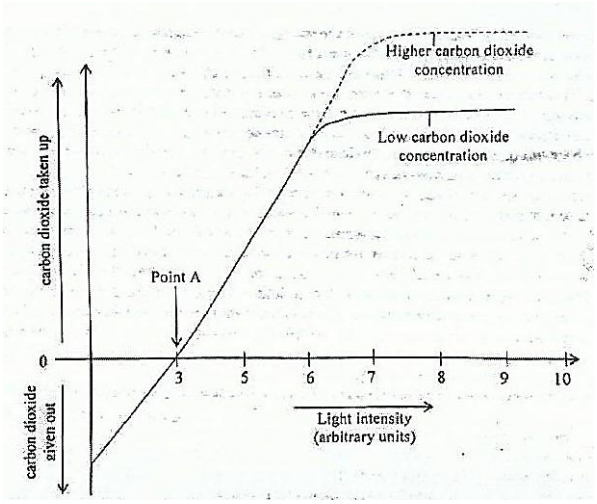
(ii) the rate of release of oxygen was used to measure the rate of photosynthesis. (02 marks)

When photosynthesis proceeds, oxygen is released as a byproduct therefore the rate of oxygen release is a good indicator of the rate of photosynthesis.

f) Name two factors that may limit the rate of photosynthesis of plants previously grown in high light intensity, if subjected to light intensity above 25 arbitrary units. (02 marks)

- Water content
- Temperature
- Carbon dioxide concentration

23. The graph in figure 1 below represents the rate of photosynthesis as measured by the amount of carbon dioxide exchanged at low carbon dioxide concentration and at higher carbon dioxide concentration with varying light intensity. Study it and use it to answer the questions that follow.



a)(i) Describe the rate of photosynthesis at low carbon dioxide concentration. (08 marks)

From 0 to 3 arbitrary units light intensity; carbon dioxide given out decreases rapidly; becomes zero at 3 arbitrary units of light intensity.

From 3 to 6.2 arbitrary units of light intensity; carbon dioxide taken up increased rapidly.

From 6.2 to 7 arbitrary units of light intensity; carbon dioxide taken up increases slowly; attaining maximum carbon dioxide uptake at 7 arbitrary units of light intensity. From 7 to 9 arbitrary units light intensity, carbon dioxide taken up remains constant.

(ii) Explain your description above.

As light intensity increases; photosynthesis begins as carbon dioxide from respiration is being utilized as a photosynthetic substrate. As light intensity increases from 0 to 3 arbitrary units; rate of photosynthesis increases although rate of respiration is still greater than that of photosynthesis. Carbon dioxide given out from respiration thus decreases rapidly; as photosynthesis increases. With the continuing increase in light intensity; a point is reached where carbon dioxide is neither evolved nor absorbed i.e. carbon dioxide produced in respiration exactly balances with that used in photosynthesis.

Further, increase in light intensity result in a proportional rise in the rate of photosynthesis until light saturation is reached. Rate of photosynthesis being greater than that of respiration implies increasing carbon dioxide take up. Beyond the light saturation point; further increases in light

intensity have no effect on the rate of photosynthesis as carbon dioxide concentration is limiting the photosynthesis process.

b) Give one difference between higher carbon dioxide concentration and low carbon dioxide concentration.

At higher carbon dioxide concentration, light saturation is attained at a higher light intensity while for lower carbon dioxide concentration, light saturation is attained at lower light intensity.

c) Use the graph above to explain why environmentalists recommend afforestation as a mode of reducing global warming. (04 marks)

Low atmospheric carbon dioxide concentration is a major limiting factor to photosynthesis. The core cause of global warming, being a planetary rise in carbon dioxide concentration implies that introduction of vegetation cover through afforestation would increase rate of photosynthesis in the presence of a higher carbon dioxide concentration. The overall effect is a reduction in atmospheric carbon dioxide.

d)(i) Name point marked A on the graph and explain what occurs at this point. (02 marks)

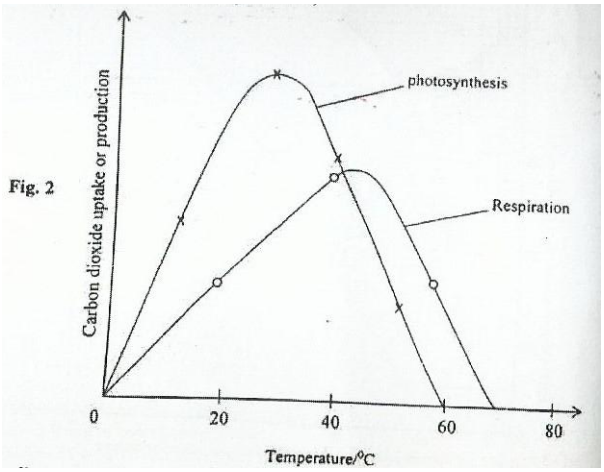
Compensation point

Carbon dioxide released during respiration equals that taken up during photosynthesis.

(ii) Suggest and explain what would happen to a point A if instead a shade plant was used.

Point A will be reached at a lower light intensity/ lower compensation point; because shade plants have lower respiratory rates and can absorb light of low intensity more efficiently; permitting higher photosynthetic rate in light of lower intensity.

e) Figure 2 below is a graph showing effect of temperature on the rate of photosynthesis and respiration in well illuminated leaves. (Light and other variables kept constant)



(i) Compare the effect of temperature on the rate of photosynthesis and respiration.

Similarities

- For both CO_2 production in respiration and CO_2 uptake in photosynthesis, increase from 0 to 28^0C
- Both CO_2 production in respiration and CO_2 uptake in photosynthesis attain peak at some temperature
- At 40^0C, CO_2 production in respiration and CO_2 uptake in photosynthesis are equal.
- For both CO_2 production in respiration and CO_2 uptake in photosynthesis, increase from 44 to 60^0C

Differences

Carbon dioxide uptake in photosynthesis	Carbon dioxide production in respiration
Generally higher between 0 to 40^0C	Generally lower between 0 to 40^0C
Generally lower between 40 to 60^0C	Generally higher between 40 to 60^0C
Increase rapidly between 0 to 29^0C	Increase gradually between 0 to 29^0C
Attains higher peak	Attains a lower peak
Peaks at a lower temperature	Peaks at a higher temperature
Zero between 60 to 70^0C	Reduce rapidly to zero between 60 to 70^0C

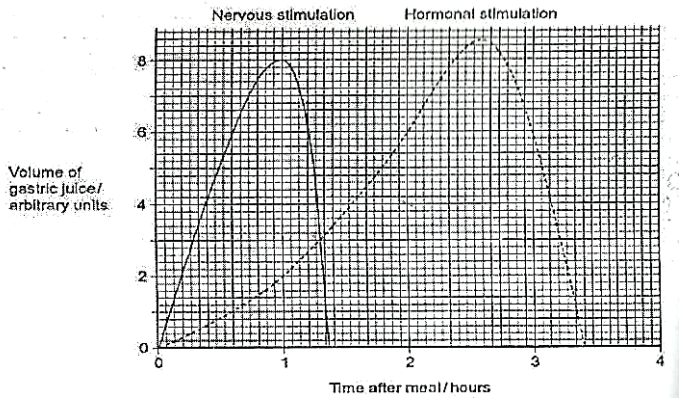
(ii) Suggest a possible reason why the rate of respiration is less affected by temperatures above 40^0C than the rate of photosynthesis.

Besides denaturation of the photosynthetic enzymes, there is a possibility of photorespiration that increases with increase in temperature for C_3 plants. A high temperature favours a more rapid increase in the oxygenase activity of Ribulose bisphosphate carboxylase (RUBISCO) than the carboxylase activity. Photorespiration antagonizes photosynthesis and reduces its rate.

(iii) What would be the effect of rise in temperatures on the rate of photosynthesis if the intensity of light falling on the leaf was very low? (03 marks)

Rate of photosynthesis will level off and finally reduce because the low light intensity limits the process of photosynthesis.

24. Cells in the stomach wall release gastric juice after a meal. The graph shows how the volumes of gastric juice produced by nervous stimulation and by hormonal stimulation change after a meal.



a)(i) Compare the changes in volume of gastric juice shown by the two curves.

Similarities

- No gastric juice release at both stimulation conditions before meal at 0 hours
- Gastric juice levels were the same at 0 hours and 01:45 hours at both stimulation

- Both stimulations caused a rise to a peak/ maximum in gastric juice secretions
- Both simulations caused a rise in gastric juice volume just after the meal
- From 0 hours to 1 hour, volume of gastric juice was increasing at both stimulation conditions

Differences

Nervous stimulation	Hormonal stimulation
For one hour just after a meal, volume of gastric juice rose rapidly	Volume of gastric acid rose gradually
Gastric juice release lasted a shorter time (1.5 hours after the meal)	Lasted longer time (3.4 hours after the meal)
Reached a lower peak	Reached a higher peak
Volume of gastric juice reached peak in one hour after a meal (after a shorter time)	Reached peak in 2.5 hours after meal (after a longer time)
From 1 hour to 1.4 hours, volume of gastric juice fell very rapidly	Volume of gastric juice had a gradual rise

(ii) Describe the evidence from the graph that curve A represents the volume of gastric juice produced by nervous stimulation.

Volume of gastric juice increased rapidly just after a meal; Gastric juice secretion lasted a very short time. The release of gastric juice by the nervous stimulation is more rapid/ very test/ immediate; and decreases rapidly just like nervous communication whereas hormonal stimulation is slower/ gradual; then increases rapidly after sometime long lived and then decreases rapidly.

(iii) How are the changes shown by the graph brought about?

Nervous reflexes

b) The table summarizes mechanisms of control of release of digestive secretions along different parts of the gut.

Part of gut	**Control mechanism**

Mouth	Nervous only
Stomach	Both nervous and hormonal
Ileum	Hormonal control only

i) Discuss the variation in the trend of control of release of digestive secretions.

Mouth; nervous is rapid since food reaches mouth in the shortest time and short lived since digestion in mouth lasts a very short time.

Stomach; nervous since food rapidly reaches stomach following the swallowing reflexes; and hormones whose effect is long lived since the stomach is large thus temporarily stores food for a relatively longer time ensuring digestion of proteins occur.

Ileum; hormonal (slow but long lived effect); food takes long to reach ileum thus needs a mechanism that is so slow but lasts a very long time in the ileum and thus requires hormonal mechanism whose effect is long lived.

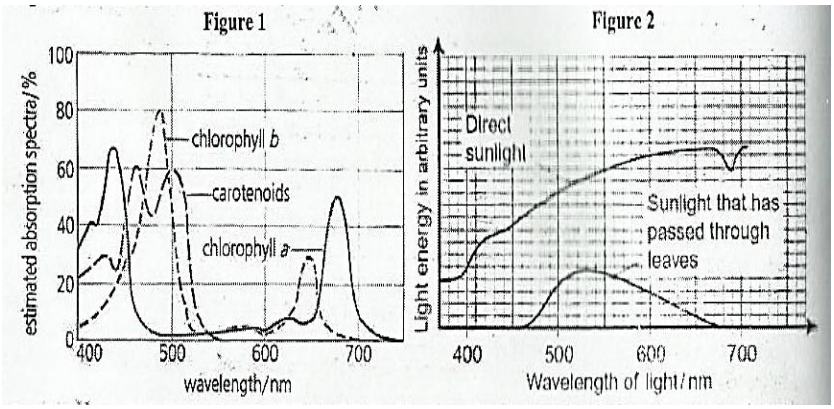
c) Explain why release of digestive secretions in man should be controlled.

- Prevent wasteful use of energy in release of secretions without digestive work to be done
- Increase efficiency by ensuring release of secretions in presence of food to be digested
- Prevents waste of materials e.g. secretions in case there is no food
- Prevents self/ auto-digestion of gut walls (made of proteins) by proteolytic enzymes
- Prevents development of gastric ulcers due to acid release in absence of food; which neutralizes acid effect on gut walls.

25. Chlorophylls and carotenoids are plant pigments that absorb light for photosynthesis. Different species of plants contain different amounts of these pigments. The pigments that each plant species has are adaptations to where and how they live their ecological niche.

Figure 1 shows the absorption of light of different wavelengths by chlorophyll a, chlorophyll b and carotenoids. Another study was carried to show the amount of energy in light of different wavelengths reaching the ground in the forest. The energy was measured in direct sunlight and sunlight that had passed through the leaves of the trees.

Figure 2 shows the result of the study



Sun leaves and shade leaves are two different kinds of leaves on beech trees. Sun leaves grow on branches exposed to direct sunlight, shade leaves grow on branches exposed to light that has passed through leaves. An ecologist collected sun leaves and shade leaves from beech trees and determined the mean mass of each photosynthetic pigment in both types of leaf. The results are as shown in figure 3 below.

Photosynthetic pigment	**Mean mass of each pigment per m^3 of leaf area/ micrograms**	
	Sun leaves	**Shade leaves**
Chlorophyll a	**299.3**	**288.9**
Chlorophyll b	**90.7**	**111.1**
Carotenoids	**0.10**	**0.07**

a) Plot a suitable graph to represent the data in figure 3 above

b) Describe the absorption of light of different wavelength by chlorophyll. (08 marks)

Below 400nm, absorption of light is high and increasing gradually; From 400nm to 430nm, light absorption increases rapidly reaching highest peak. From 430nm to 450nm, light absorption decreases rapidly and the gradually decreases from 450nm to 520nm. From 520nm to 600nm, no absorption of light occurs.

From 600nm to 640nm, absorption of light increases gradually. From 640nm to 670nm, light absorption increases rapidly to the second peak; then decreases rapidly from 670nm to 700nm and finally decreases gradually to the minimum beyond 700nm.

c) Comment on light absorption of different wavelengths by chlorophylls and carotenoids. (06 marks)

- Between 550nm and 600nm there is no absorption of light by all pigments because the wavelengths are reflected
- Each pigment shows at least two peaks of absorption
- All pigments show maximum absorption between 400nm and 500nm
- Highest peaks of absorption of chlorophyll a and b are higher than the peaks of carotenoids
- Chlorophyll b shows the highest absorption
- Absorption occurs over a wide range of wavelengths for chlorophyll a and b but no absorption by carotenoids occurs beyond 550nm.

d) **Explain**:

(i) The advantage of producing more chlorophyll b in shade leaves to beech trees. (03 marks)

Enables them to absorb light from a wavelength chlorophyll a cannot absorb efficiently for example between 440nm and 550nm and between 600nm and 650nm allowing their continued photosynthesis hence their survival.

(ii) Why in leaves at the top of trees in a forest, CO_2 is often the limiting factor for photosynthesis. (02 marks)

- There is a lot of light as there is no shading thus light dependent reaction not limiting high utilization of CO_2.
- It is always warm allowing fast activity of enzymes in the light independent reactions.

f) Each type of pigment is produced by a specific enzyme-controlled pathway. Suggest how the same plant can produce more pigment in some leaf cells than others. (02 marks)

Greater amounts of enzymes for production of chlorophyll b; greater gene expression/ transcription of the gene/ more mRNA/ genes switched on; thus greater translation.

g) Suggest the morphological adaptations of plants for shady environments. (08 marks)

(i) Explain the other significance of carotenoids to the beech tree besides trapping light. (02 marks)

- Stomatal density is low to avoid over cooling
- Palisade to spongy mesophyll ratio is low to allow maximum light penetration
- Leaf orientation horizontal to maximize light trapping
- Dark green color of the blade due to increased chlorophyll to enhance light absorption in the dark
- Thin leaves to maximize light penetration
- Stomatal size large to allow loss of excess water
- Elongated internodes for accessing light

26. (a) Outline the different digestive juices and the roles they play. (05 marks)

Saliva; softens and lubricates food, binds food particles together, contains amylase; digests starch to maltose;

Gastric juice; acid kills bacteria in food; pepsin hydrolyses proteins to polypeptides; renin (coagulates milk protein)

Bile juice; bile salts neutralize acidic chime; emulsify fats

Pancreatic juice; trypsin hydrolyses proteins to amino acids, amylase hydrolyses starch to maltose, lipases digest lipids to fatty acids and glycerols.

b) Discuss the nervous and hormonal control of digestion in: (15 marks)

In the mouth conditioned reflexes e.g. thought, smell and sight coupled with unconditioned reflexes when present in the mouth, leads to secretion of saliva by salivary glands. Saliva contains salivary amylase which hydrolyses starch in the mouth partly to maltose; saliva also softens and reduces friction easing swallowing. Secretion occurs in the three phases i.e. cephalic, gastric and intestinal phases. Smell, sight or mere thought of food initiates the

cephalic phase through the conditioned and unconditioned reflexes. HC1 and pepsinogen secretion begins; reaches peak within 30 minutes. Gastric phase starts when food has just entered the stomach; nervous stimulation of the stomach walls causes G cells within the gastric antrum, secrete gastrin, which stimulates release of gastric juice, whose major components are HC1, pepsin, renin and gastric lipase. In the duodenum intestinal phase begins; presence of acidic fatty chime; stimulates the release of secretion and CCK-PZ from the duodenal mucosal cells, which counteract gastric acid secretion; increases GIT motility; facilitates rapid stomach emptying. Secretin and CCK-PZ also stimulate release of pancreatic juice; also cause contraction of gall bladder smooth muscles; producing bile into the duodenum at the sphincter of Oddi. Bile salts neutralize the acidic chime as well as emulsifying fats. Pancreatic juices contain enzymes; pancreatic carbohydrases e.g. amylases, pancreatic lipases, enterokinases, chymotrypsin, trypsin, carboxypeptidases and nucleases. In the ileum, presence of chyme stimulates release of Enterocrinin; stimulate release of Succus entericus; containing enzymes; maltases, sucrases, lactases lipases, which complete digestion of carbohydrates, proteins and fat substrates. Both GIT secretions and motility are controlled by the enteric nervous system. Meissner's plexus controls GI secretions while the myenteric/ Auerbach's plexus controls GI motility. Inhibitory controls include fats which stimulate secretion of Enterogastrone; from the stomach walls; inhibiting HCI secretion which also stops secretion of salivary amylases. Evacuation reflexes and gastro colic reflexes are spinal.

27(a) Describe the significance of pigments and light in photosynthesis. (12 marks)

Role of pigments

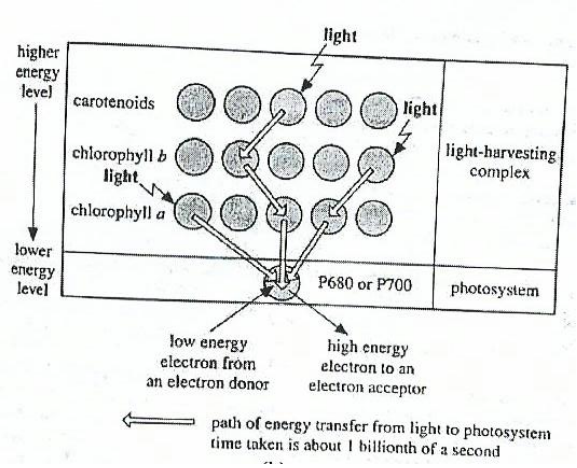
Photosynthetic pigments do absorb light energy and convert it to chemical energy. These include primary pigments i.e. chlorophyll a and b and accessory pigments i.e. carotenoids (carotenes and xanthophylls) and phaeopytins primary pigments, besides absorbing from their respective ranges (red and blue – violet ranges) receive additional solar energy from carotenoids (that absorb from the blue-violet range; All the energy is finally transferred to chlorophyll a; broadening the range of light utilizable by the plant.

Accessory pigments also protect chlorophylls from excessive light and from oxidation by oxygen produced during photosynthesis; excites electrons at the reaction centres;

Bacteriochlorophyll in photosynthetic bacteria; absorbs light energy from the UV and infrared range.

Role of light

Light provides solar energy during the light dependent stage which excites electrons; boost them up to higher energy levels and their transition through a series of electron carriers downhill in terms of energy; yields energy that is used to combine ADP with Pi to form ATP; Light, besides facilitating generation of ATP through cyclic and non-cyclic photo phosphorylation; also facilitates photolysis of water; generates hydrogen ions which stabilize photo system II and also reduce NADPH; a compound incorporated into the Calvin cycle in the light independent stage; reducing glycerate-3-phosphate to triose phosphate;



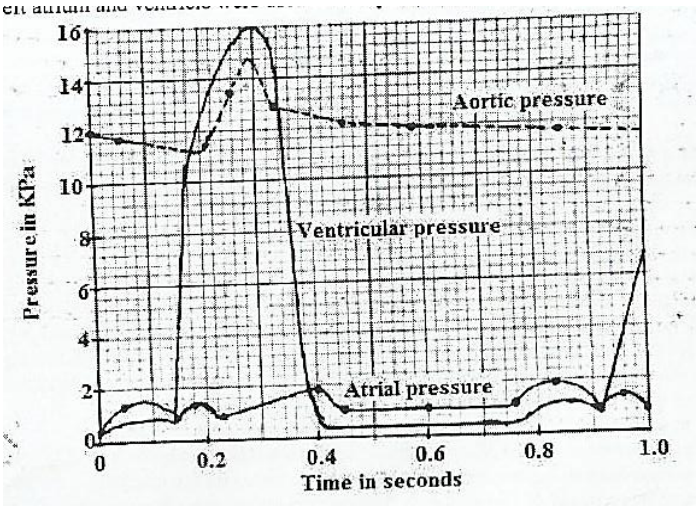
b) How does altitude affect the distribution of C_3 and C_4 plants? (08 marks)

High altitude favors more growth of C_3 plants than C_4 plants; due to the low/cool temperatures; which permit C_3 plants to fully open their stomata; obtain adequate carbon dioxide without risk of excessive water loss through transpiration; High carbon dioxide concentration ably outcompetes oxygen at the active site of Ribulose bisphosphate carboxylase (RUBISCO); increasing photosynthetic efficiency as well as decreasing chances of photorespiration; Moderate-low altitude favors more existence of C_4 plants than C_3plants because of their highly effective CO_2 fixing enzyme Phosphoenol pyruvate carboxylase (PEP carboxylase); whose high

optimum temperature makes it tolerant to high environment temperatures; present at mid-altitudes; C_4 plants are also resistant to photorespiration; which increases their photosynthetic efficiency.

TRANSPORT

28. Figure 1 below shows the changes in the pressure that takes place within the atria, ventricle and aorta during one cardiac cycle. The left atrium and ventricle were used to easily relate their pressure changes with that of the aorta.



a) Using figure above;

(i) Calculate the heart rate in beats per minute. Show your working. (02 marks)

1 beat takes 0.74 seconds

0.74 seconds are required to complete 1 beat

60 seconds are required to complete (60/0.74) beats = 81 beats per minute

(ii) Determine how long is the valve between the left atrium and the left ventricle closed? Explain how you arrived at your answer. (02 marks)

Valve closed when ventricular pressure exceeded atrial pressure at 0.14 seconds; and opened when ventricular pressure decreases below atrial pressure at 0.38 seconds;

Time when valve remained closed = 0.38 – 0.14 = 0.24 seconds.

(iii) Describe the changes in aortic pressure in a single heartbeat. (06 marks)

From 0 seconds to 0.2 seconds aortic pressure decreases gradually; from 0.2 seconds to 0.28 seconds aortic pressure increases rapidly to the maximum; from 0.28 seconds to 0.34 seconds aortic pressure decrease rapidly; from 0.34 seconds to 0.74 seconds, aortic pr4essure decreases gradually;

b) Explain the significance of the differences in the following pressure changes.

(i) Atrial pressure and ventricular pressure. (08 marks)

Between 0 seconds and 0.14 seconds, atrial pressure is above/higher than ventricular pressure; atrium is contracting, forcing blood into the ventricle; between 0.14 seconds to 0.38 seconds ventricular pressure is above/ greater than atrial pressure; ventricles contract; forcing semi-lunar valves to open; forcing blood into the aorta; between 0.38 seconds and 0.74 seconds atrial pressure is slightly above the ventricular pressure, both atrium and ventricle are relaxed; atrio-ventricular (bicuspid) valves open; blood begins to flow into the ventricle.

(ii) Aortic pressure and ventricular pressure. (09 marks)

Between 0 seconds and 0.2 seconds, aortic pressure is higher than ventricular pressure; to keep semi-lunar valves closed as blood is filling in the ventricles; between 0.2 seconds and 0.36 seconds; ventricular pressure is higher than aortic pressure; ventricles are contracting building pressure to force open the semi-lunar valves; to allow blood enter into the aorta; between 0.36 seconds and 0.74 seconds, ventricular pressure is higher than aortic pressure; ventricles relax; while the aorta contract; forcing blood slightly backwards to close the semi-lunar valves; preventing backflow of blood into the ventricles.

c) What is the effect of changes in ventricular pressure on the volume of ventricles? (05 marks)

From 0 seconds to 0.14 seconds, slight increase in pressure results into a slight decrease in volume of the ventricles/ volume remains almost constant; from 0.14 seconds to 0.28 seconds, rapid increase in ventricular pressure results in rapid decrease in ventricular volume; to the minimum; from 0.28 seconds to 0.4 seconds rapid decrease in ventricular pressure results into

rapid increase in volume of the ventricles back to normal; from 0.4 seconds to 0.74 seconds, ventricular pressure remains almost constant resulting into no effect on the volume of ventricles.

d) Suggest reason(s) for the difference in pressure in the right ventricle and that in the left ventricle of the heart. (04 marks)

Left ventricle has a higher pressure; its walls are thicker hence more muscular; to pump blood to longer distances (to all parts of the body); whereas the right ventricle wall is thinner; as it pumps blood to shorter distances preventing damage to the thin walls of blood vessels in pulmonary circulation.

e) State the adaptations of the heart to its function(s)

- Valves; to ensure flow of blood in a single direction
- Elastic to allow expansion to accommodate the large volume of blood
- Highly muscular for generation of greater contractile force to pump blood at high pressure
- Supplied with coronary arteries to supply oxygen and nutrients to the cardiac muscles
- AVN spreads out waves of excitation to lower apex/ vertex of the ventricles
- The lining of inner chambers consist of squamous epithelium to allow smooth flow of blood in the heart
- Surrounded by pericardium to limit expansion of the heart to maintain the internal pressure
- Septum to separate oxygenated and deoxygenated blood preventing them from mixing
- Innervated by the vagus nerve (parasympathetic) and sympathetic nerves to control heart rate
- Valve tendons attached to atria-ventricular walls to support valve preventing them from turning inside out due to changes in heart chambers.

30 (a) Describe the events of the cardiac cycle. (10 marks)

Atrial systole; Both atria contract; small amount of remaining blood forced into the relaxed ventricles via the open AV valves; Ventricular systole; both ventricles contract; the atrio-

ventricular valves are pushed shut by the pressurized blood in the ventricles; heart sound 1 (lub) produced; Ventricular pressure being greater than arterial pressure forces semi-lunar valves open; Blood ejected from the ventricles into the arteries; Atrial and ventricular diastole; ventricles and atria relax; ventricular pressure drops; blood flows back against the cusps of semi-lunar valves; forcing them closed; 2^{nd} heart sound (Dub) produced; blood then flows from the veins through the relaxed atria into the ventricles; which fill passively and the cycle continues.

b) Explain how the heart action is controlled? (07 marks)

Intrinsically the heart rate is controlled by a set of specialized cardiac cells which initiate and distribute electrical signals myogenically throughout the heart; The SAN as the pacemaker; spreads electrical excitations to atria; making them contract; excitation wave then reaches the AVN; which delays and relays signals through purkyne tissue; and the bundle of His; to the ventricles; which then contract. Extrinsically the heart rate is controlled by the autonomic nervous system; Sympathetic nervous system releases noradrenaline; facilitates depolarization of cardiac muscles; increases cardiac activity; Parasympathetic nervous system (vagus nerve); releases acetylcholine; hyperpolarizes cardiac tissue; decrease cardiac activity; other extrinsic controls include; baroreceptor activity, hormones like thyroxine, age, exercise and body temperature.

c) Explain what will happen to the heart when the vagus nerve is cut? (03 marks)

Heart rate will increase. Cutting the vagus nerve cuts off the parasympathetic interventions of the heart. This is therefore unopposed sympathetic nervous system activity; causing rise in nodal conduction and hence an overall rise in heart rate.

31 (a) Discuss the factors that may alter the rate of heart beat in mammals. (10 marks)

Environmental temperature; increases metabolic rate; heartbeat is faster when the external temperature is high. Level of activity/ exercise; increased muscular activities result in increased carbon dioxide in the body which results in a higher heart rate.

Effect of hormones; hormones like adrenaline increases heart rate to prepare for escape.

Effect of neurotransmitters; acetylcholine inhibits heart beat while noradrenaline increases heartbeat.

Effect of drugs/ poisons; some drugs inhibit while others accelerate heart rate

State of health; heart rate is faster in diseased organisms due to increased carbon dioxide& temperature.

Body size; Small organisms have a higher heart rate than larger ones due to their higher metabolic rate;

Age; Young organisms have higher metabolic rate due to rapid growth and hence higher heart rate;

Environmental temperature; Increase in temperature increases metabolic/respiratory rate leading increase in heart rate to eliminate excess carbon dioxide and to supply metabolites;

State of emotion; increase heart beat causing supply of more nutrients to tissues;

Sex; heart rate is higher in males than females since males arc poorly insulated leading to higher metabolic rate;

b) What is the physiology of Bohr effect in animals? (08 marks)

Bohr effect is the shifting of the oxygen dissociation curve downwards and to the right due to increase in the partial pressure of carbon dioxide in the blood. A high carbon dioxide concentration/low pH in the tissues reduces the ability of haemoglobin to associate with oxygen/ reduce the affinity of haemoglobin for oxygen thus the oxy haemoglobin will dissociate faster into oxygen and haemoglobin. Bohr effect is due to the reduction in pH caused by dissolution of carbon dioxide in water forming weak carbonic acid; which partially dissociate into hydrogen ions and hydrogen carbonate ions. The dissociation curve shifts lo the right as the oxyhaemoglobin dissociates to release oxygen to the tissue; High PH or low partial pressure of carbon dioxide; increases hemoglobin's ability to associate with oxygen.

c) Explain why according to the mass flow hypothesis, translocation can only take place in living phloem.

Loading and unloading the sieve tube elements is an active process; carried out by living companion cells.

11(a) State the ways by which flowering plants obtain nutrients and water. (05 marks)

Water

- Sources include, available soil water, metabolic by-products.

- Hydrotropism
- Taken in by root hairs from the soil solution; by osmosis along the concentration gradient

Nutrients

- Uptake by diffusion and active transport form the soil solution via the root hairs.
- Mycorrhiza association; plant roots symbiotically associate with the fungi; facilitating absorption of nutrients.
- Association with nitrogen fixing bacteria.
- Nitrifying bacteria facilitate absorption of nitrates by absorbing them from ammonium compounds,
- Parasitic and carnivorous/ insectivorous feeding interactions.

b) Describe the pathways and mechanisms by which water moves right from roots to the leaves. (15 marks)

Symplastic pathway; Water enters the cytoplasm by osmosis through the partially permeable cell surface membrane. Water moves into the sap in the vacuole, through the tonoplast by osmosis or from cell to cell through the plasmodesmata or through adjacent cell surface membranes and cell walls.

Apoplastic pathway; Water enters and moves through the cell wall then either directly from one cell wall to another or through the intercellular spaces.

Vacuolar pathway; here water is osmotically drawn from sap vacuole of one cell to that of another adjacent cell along the osmotic gradient. Pathway provides some resistance to movement of water.

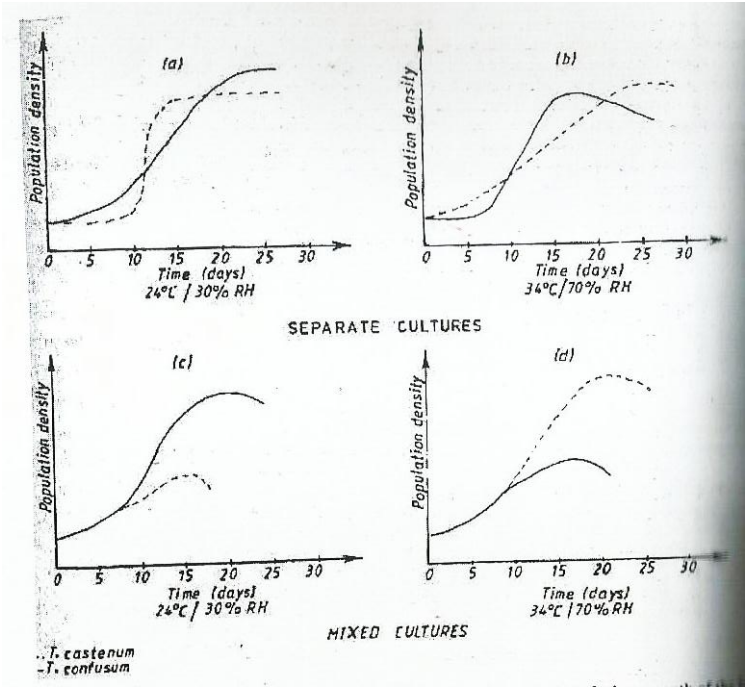
Mechanism

Root endodermis actively pumps salts from the cortex into the xylem vessels of the root. Casparian strip prevents leaching out of the ions back to the cortex. Water potential in the xylem tubes thus gets lowered and a water potential gradient is created which forces an osmotic influx of water from the endodermal cells to the root xylem via the symplast pathway. Accumulation of water in the root xylem creates a root pressure reduced only by water moving up the stem. Water therefore moves up the stem xylem under the influence of transpiration

pull, capillarity, cohesion and adhesion. Flow through the stem xylem is continuous since the xylem vessels have no end walls to restrict flow. Water enters the leaf xylem following an osmotic gradient created when water is lost into the atmosphere cither through stomatal transpiration or evaporation. Movement across the cortex and the leaf may also be through cell walls alone and plasmodesmata by the apoplast and symplast pathways.

ECOLOGY

QN 33. **Two laboratory experiments to study the population growth of two species of flour beetles (Tribolium castenum and T. confusum) that were carried out under two sets of conditions of temperature and humidity. In the first experiment, the two species were cultured separately at 24^0C and 30% relative humidity and 34^0C and 70% relative humidity. In the second experiment the beetles were cultured together under similar temperature and relative humidity conditions as in the first. The results obtained in experiment 1 are shown in figure 1 (a) and (b), and those obtained in experiment 2 are shown in figure (c) and (d). Study the figure and answer the questions that follow.**



a) What is the effect of raising temperature and relative humidity on the population growth of the beetles in experiment 1?

T. Castenum

- Raising temperature and humidity increased the population growth.
- The population growth showed a gradual increase up to a maximum
- At higher temperature and humidity, maximum population density was attained later, on the 25th day, than at lower temperature and humidity which was attained on about the 14th day.
- Maximum population density was higher at raised temperature and relative humidity.
- After attaining the maximum at raised temperature and humidity, the population density showed slight decrease, yet at low temperature and humidity it remained constant.

T. confusum

- Raising temperature and humidity initially in the five days stopped or inhibited the growth of T. confusum. There after caused an exponential/ rapid increase to a maximum.
- The maximum population density was attained earlier; on about the 16th day; at raised temperature and humidity as compared to that of lower temperature and humidity which occurred on about the 23rd day.
- Maximum population density was lower at raised temperature and relative humidity
- After attaining the maximum population density at raised temperature and humidity the population density of T. confusum gradually decreased; yet at lower temperature humidity it remained constant.

b) Explain the interaction of the two species of beetles in experiment 2?

At low temperature and humidity, T. confusum had a competitive advantage; out-competed T. castenum. T. confusum thus had a higher maximum population density that was attained on a later day (20th day) compared to the 15th day for T. castenum at raised temperature and humidity T. castenum had a competitive advantage out competed T. confusum. Maximum population density for T. castenum was higher and was attained later on about the 21st day

compared to T. confusum which was attained on the 16th day. In both after attaining the maximum population density there us a decline in population growth at both low and raised temperature and humidity. This could be due to accumulation of toxins, reduction in food resources and death rate exceeding reproduction rate.

c) Explain why the population of the beetles in experiment 1 level off.

Populations of the beetles level off as they reach the carrying capacity or saturation point; the maximum that the culture can support. At this point further increase is stopped due to limitation by density dependent factors such as competition for food, mates and space, and accumulation of waste and over-crowding. The reproductive rate is in balance with the death rate.

d) Suppose experiment 2 was to continue running for a few more days, suggest with reasons what would happen to the populations of the beetles?

At low temperature and humidity, population of T. castenum would drastically decrease and possibly become extinct. T. confusum having a competitive advantage would remain in the culture, may start to increase as T. castenum becomes extinct. Population density of T. confusum would gradually increase; soon reaching a new carrying capacity; where its population density would remain relatively constant. At raised temperature and humidity population of T. confusum would gradually decrease and possibly become extinct. Population of T. castenum would then start to increase with limited interspecific competition, as T. confusum becomes extinct. T. castenum would reproduce greatly and its population would soon reach a relatively constant, new carrying capacity.

e) How do the results of these two experiments relate to a natural ecosystem?

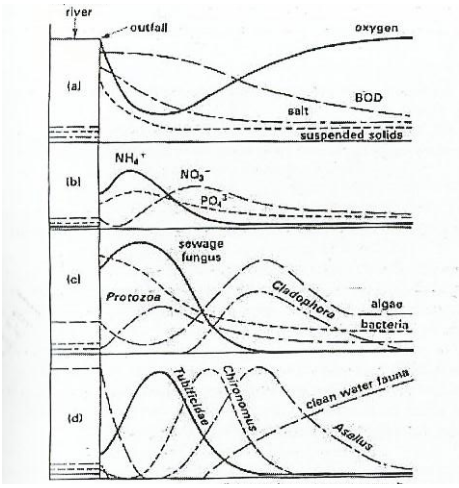
- In limited natural resources individuals of a given species tend to reproduce attaining their biotic potential.
- Changes in environmental conditions result in changes in population density of different species as they adapt to the new environments.
- Some individuals have favorable traits and are more adapted to survive in prevailing environmental conditions than others.

- Competition between members of different species reduces their carrying capacity and may cause extinction of the less adapted individuals.
- Each species has a favorable set of environmental conditions for its maximum rate of reproduction as its ecological niche in a natural ecosystem.

QN 34 . The graphs below were obtained in a study on the effect of sewage discharge into a river. Graph A and B show physical and chemical changes.

Graph C shows changes in micro organisms

Graph D shows changes in aquatic invertebrates



a) What is meant by the term biochemical oxygen demand (BOD) and how is it measured?

BOD is mass of oxygen consumed by microorganisms in a sample of water in a given time. It is usually measured as the mass (in mg) of oxygen used by 1 dm^3 of water stored in darkness at 20^0C for 5 days.

b) Explain the changes in BOD shown in the diagram?

Dissolved oxygen level is high in unpolluted water; decreases rapidly at sewage discharge to the minimum; and then increases gradually downstream, returning to a normal level further downstream. BOD is very low in unpolluted water, increases rapidly at sewage discharge then decreases gradually downstream. This is because of decomposition of organic components of sewage by aerobic bacteria coupled with reduced photosynthesis because of low illumination caused by suspended solids in sewage rapidly reduce oxygen (cause oxygen sag) and create a high BOD at outfall. The gradual increase of dissolved oxygen downstream is because of

increased photosynthesis and dissolution from atmosphere. The death of aerobic bacteria due to reduction in organic substances decreases BOD downstream.

c) Describe the changes in the:

(i) physical and chemical components

Dissolved oxygen; drastically decreased within a short distance downstream after the sewage outfall to minimum then gradually increased further downstream to a maximum; above the level in unpolluted water upstream;

Suspended solids; downstream decreased gradually after the sewage outfall; to a level downstream that is similar to that in unpolluted water upstream; remained constant further downstream.

Salt levels; decreased gradually downstream to a level that is higher than that upstream in the unpolluted waters; remained constant further downstream.

BOD; initially decreased very slightly downstream; then further downstream it is decreased more gradually to a level that is higher than in the unpolluted water upstream;

Ammonium ion (NH_4^+); concentration increased drastically to the maximum at a short distance downstream from the point of sewage outfall; they decreased gradually further downstream and remained constant; at a level slightly higher than that in unpolluted water upstream;

Nitrate ion (NO_3^-); initially decreased to a minimum with a short distance after a sewage outfall; then it increased gradually to a maximum; further downstream it decreased gradually and then remained constant; at a level higher than in unpolluted water upstream;

Phosphate ion concentration; increased gradually to a maximum; at short distance downstream from the point of sewage outfall; there after it decreased much gradually then remained constant downstream; at a level slightly higher than that in unpolluted water upstream. In unpolluted water upstream, there was no sewage fungus

(ii) micro organisms

Sewage fungus; increased gradually to a maximum & short distance downstream after the point of sewage discharges: thus after it decreased gradually to a minimum & remained; constant further downstream;

Cladophora; was not in unpolluted waters upstream and only appeared further downstream; there numbers gradually increased to a maximum; then decreased gradually further downstream;

Unicellular heterotrophs; were few in unpolluted waters; after sewage outfall they increased gradually to a maximum; then decreased gradually and remained constant further downstream;

Algae; population was higher than other micro-organisms in unpolluted waters upstream; after the sewage outfall algae decreased gradually to a maximum further downstream thereafter algae decreased gradually and finally remained constant; at a level slightly higher than that in unpolluted waters upstream;

Bacteria; were more than unicellular heterotrophs in unpolluted waters but less than algae; after the sewage outfall bacteria drastically increased to a maximum at the point of discharge they then decreased gradually and more gradually downstream; thereafter bacteria remained constant at a level slightly higher than that in unpolluted waters upstream;

(iii) Aquatic invertebrates

Tubificidae was the least in the unpolluted waters; increased gradually after sewage outfall; to a maximum a short distance downstream; before any other invertebrate hits its maximum; thereafter it decreased gradually and remained ton slant downstream; at a level comparable to that in unpolluted waters upstream; Clean water fauna was the highest in the unpolluted water; after the sewage out fall they decreased drastically and were totally absent a short distance downstream from the point of sewage outfall; further down there appeared and increased gradually to a number comparable to those in unpolluted waters upstream;

Chironomus were few in unpolluted waters upstream; after the sewage outfall they decreased slightly to a minimum a short distance after the point of discharge; they increased drastically to a maximum midstream; after which they decreased initially drastically then gradually and finally remained constant; further downstream.

Asellus was higher than Chironomus and tubeficidae fauna but less than clean water fauna in the unpolluted waters upstream; after sewage out fall they decreased drastically and soon disappeared for a distance downstream but shortly before the clean water fauna.

QN 35 (a) what are chemo heterotrophic bacteria?

Chemo heterotrophic bacteria are bacteria that obtain energy from oxidation of chemicals in their food.

b) Give three groups of the type of bacteria in (a) above

- Saprotrophs
- Mutualists
- Parasites

c) Using examples in each case, explain the ecological importance of each of the groups in above in an ecosystem.

- Saprotrophs; e.g. bacteria; obtain food from dead decaying matter; they are chief decomposers bringing about nutrient recycling.
- Mutualists e.g. Rhizobium; nitrogen fixing bacteria is part of the nitrogen cycle as nitrogen fixers.
- Parasites, e.g. cocci and bacilli benefit from their hosts from which they obtain food and shelter; host suffers harm. Obligate parasites only survive in the host. Facultative parasites feed on the host bringing about their death and then live saprophytically on the host remains.
- Both obligate & facultative bacterial parasites are pathogens; cause disease; which check on the host population,

d) How do nitrogen fixing bacteria differ from round worms in their relationship with host?

Nitrogen fixing bacteria have a mutual benefit with the host; by providing nitrates and amino acids to the host; while deriving shelter and carbohydrates from the host.
Round worms on the other hard derive benefit from the host, which receive no again but instead is harmed. The worms can lead to death of the host.

e) What is the economic importance of nitrogen fixing bacteria?

- They recycle nitrogen in the atmosphere
- They enrich the soil with nitrates
- They fix free atmospheric nitrogen into nitrates, which can then be utilized by plants
- Their presence in the ecosystem increase productivity and hence food yield.

QN 36. Write short notes on the following ecological concepts

a)Ozone and Ozone depletion

The ozone layer forms in the upper atmosphere when UV radiation reacts with oxygen (O_2) to form ozone (O_3). The ozone absorbs UV radiations and thus prevents it from reaching the surface of the earth where it would damage the DNA of plants and animals. Various air pollutants, such as chlorofluorocarbons (CFCs), carbon monoxide and carbon dioxide enter the upper atmosphere and break down ozone molecules. CFCs have been used as refrigerants, as propellants in aerosol sprays, and in the manufacture of plastic foams. When ozone breaks down, the ozone layer thins forms ozone holes; allowing UV radiation to penetrate and reach the surface of the earth.

b) Greenhouse effect and global warming

Accumulation of carbon dioxide and other greenhouse gases like methane, CFCs, CO etc contribute to planetary global warming. The carbon dioxide layer in the atmosphere is transparent to the incoming short wavelength radiations from the sun but absorbs strongly the long wavelength radiations which the earth re-radiates into space. It therefore traps the outgoing radiations, warming the lower atmosphere which in turn radiates energy back to the earth's surface. This raises the planetary surface temperatures (greenhouse effect); and would eventually result in global warming. The drastically rising levels of carbon dioxide and other greenhouse gases may lead to increasingly warmer surface environment (enhanced greenhouse effect); increase rate of evaporation; lead to more loss of water (a powerful long wave absorber); cause further increase in surface temperatures resulting in changes in the distribution pattern and intensity of the major planetary weather systems (global warming) which would profoundly affect human activities and distribution of organisms.

c) Acid rain

The burning of fossil fuels (such as coal) and other industrial processes release into the atmosphere air pollutants that contain sulfur dioxide and oxides of nitrogen. When these substances react with water vapor, they produce sulfur acid and nitric acid. When these acids return to the surface of the earth (with rain 01 snow), they kill plants and animals in lakes and rivers and on land and makes soils acidic affect crop productivity. Acid rain also leaches magnesium and calcium from soil, eventually aluminum, manganese and other heavy metals

come into solution, reach their toxic levels; causing damage to tree roots and mycorrhizas; thus reducing the capacity of plants to take in nutrients and water. Diseases induced by mineral deficiencies emerge so commonly especially in the dry season. The problem of acid rain has been addressed through reducing release of pollutant gases, employing the desulphurization technology and adding lime to acidic water bodies.

d) Biomagnification

Biomagnification/ bioaccumulation is build-up of a metabolically persistent chemical substances or toxins high up along the trophic ladder. Many pollutants are not readily biodegradable and thus persist in environment for long periods of time. Such toxins, like the pesticide Dichlorodiphenyl trichloroethane (DDT), concentrate in fat tissue of plants and animals. As one organism eats another, the toxin becomes more and more concentrated. Biomagnification is disastrous to top carnivores as toxicity of the accumulated chemical like DDT may result in infertility, induce hormonal changes that affect calcium metabolism making birds lay thin shelled eggs that consequently break. Such hindrances to reproductive success may threaten extinction of top carnivores.

GASEOUS EXCHANGE AND RESPIRATION

16. Table 1 shows percentages by volume of some gases in inspired air, expired air and alveolar air in a resting human being.

Table 1

Gas	Percentage volume (%)		
	Inspired air	Expired air	Alveolar air
Oxygen	20.90	15.30	13.90
Nitrogen	78.60	74.90	No data
Carbon dioxide	0.03	3.60	4.90
Water vapour	0.47	6.20	No data

Figure 1(a) and (b) show effects of increased carbon dioxide concentrations in inspired air, on the volume of air breathed in and out per minute and on the breathing rate respectively.

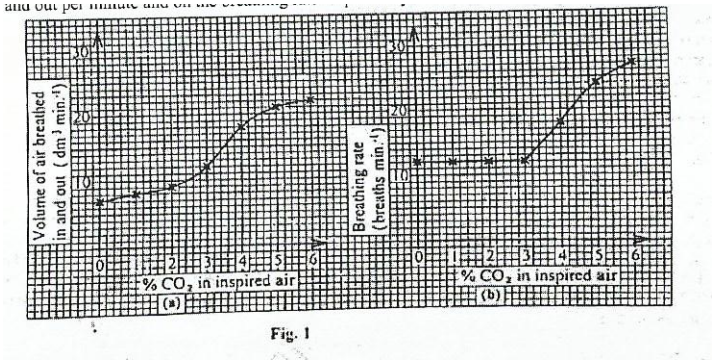


Fig. 1

a) Explain why

(i) the percentage volume of oxygen in expired air is intermediate between the inspired and alveolar values

Alveolar air has a lower percentage volume than inspired because oxygen diffuses into the blood stream; and the remaining air in the alveolus mixes with fresh air that is incoming; thus expired air is intermediate between inhaled and alveolar air/ dead space/ alveolar air.

(ii) there is a difference in percentage volume of nitrogen between inspired and expired air

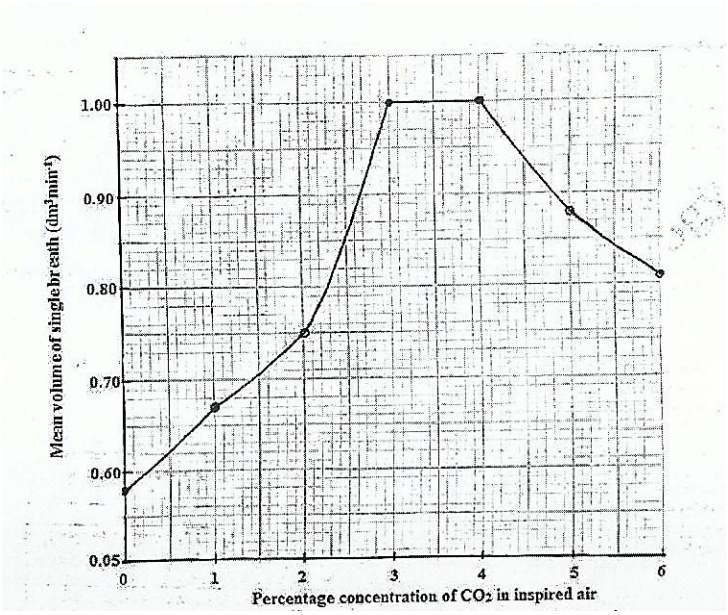
The percentage of nitrogen in expired air is less than that in inspired air because some oxygen is extracted for use by the body while more carbon dioxide is expelled; water vapour is also more in expired than in inspired air; hence the remaining percentage composition of nitrogen is reduced.

b)(i) Using the information in figure 1, calculate the mean volumes of a single breath in and out at different carbon dioxide concentrations in inspired air as indicated in table 2

Table 2

% concentration of CO_2 in inspired air	0	1	2	3	4	5	6
Mean volume of single breath (dm^3 min^{-1})	7/12 (0.58)	8/12 (0.67)	9/12 (0.75)	12/12 (1.00)	18/18 (1.00)	21/24 (0.88)	22/27 (0.81)

(ii) Plot a graph showing the mean volume of a single breath against percentage concentration of carbon dioxide in inspired air



c) Describe the effect of the increase in carbon dioxide concentration in inspired air on the

(i) Volume of air breathed in and outer minute

Volume of air breathed in and out increases gradually up to 3%; then increases fast up to 4%; then gradually up to 6%.

(ii) Breathing rate.

Breathing rate remains constant up to 3%; then increases very fast up to 5%; then slightly decreases up to 6%.

(iii) Mean volume of a single breath in and out

Mean volume of a single breath in and out increases rapidly up to 3%; remains constant up to 4% and then decreases gradually up to 6% carbon dioxide.

d) Explain the effect of the increase in carbon dioxide concentration in inspired air on the

(i) Volume of air breathed in and out per minute

Volume of air breathed in and out per minute of carbon dioxide; percentage below 3% is low because at this concentration, it is not harmful; but as the percentage increases beyond 3%; it increases the depth of breathing in order to remove a lot of carbon dioxide.

(ii) Breathing rate

Between 0 and 3% carbon dioxide concentration; the rate of breathing s constant because chemo receptors are less stimulated. Increase in carbon dioxide percentage beyond 3%, the carotid and aortic bodies of the blood system are stimulated to send impulses to the inspiratory centre; which sends impulses to the respiratory centre; which send impulses via the intercostal nerve causing the intercostal muscles and diaphragm to increase the rate of inspiration or breathing.

(iii) Mean volume of a single breath in and out

As volume of air breathed in and out per minute increases, the rate of breathing remains a constant; there- fore the mean volume of a single breath increases; and when the rate of breathing increases with volume between 3% and 4%; mean volume remains constant while the mean volume decreases slowly as the rate of breathing declines slowly with decrease of volume taken in and out per minute between 4% and 6%.

e) Outline the physiological effects in the body, of breathing in excess

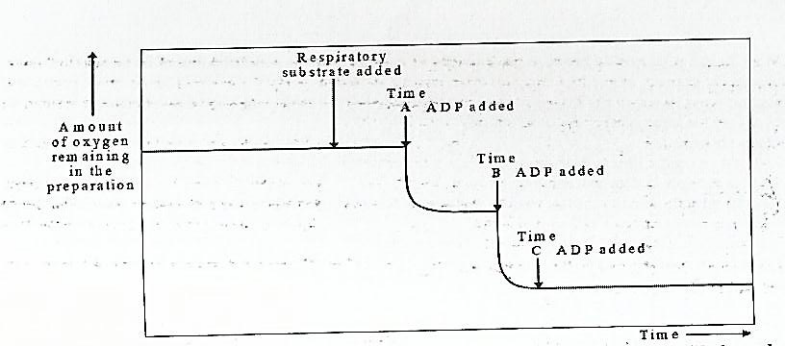
(i) Carbon dioxide

In excess CO_2, there is low pH; which encourages the dissociation of oxyhaemoglobin to release oxygen that will be utilized by body tissues.

(ii) Oxygen

In excess oxygen, pH is high so haemoglobin combines with oxygen readily and lowers the ability of oxyhaemoglobin to dissociate.

QN 37 . A preparation of mitochondria was made from liver tissue. Substances were added to this preparation and the amount of oxygen in the preparation was monitored over a period of time. The diagram shows the trace obtained and the times when the different substances were added.



a) Suggest why the respiratory substrate added to this preparation was a molecule from Krebs cycle and not glucose. (04 marks)

Mitochondria have enzymes for Krebs cycle substrates; have specialized channels for Influx of these molecules but lack specialized transmembrane proteins for glucose Influx; lack glycolytic enzymes that incorporate glucose; do not use glucose as a substrate.

b) What additional substance, other than those mentioned on the diagram, would need to be added to this preparation in order to get the results shown? (02 marks)

Inorganic phosphate, NAD, FAD^+

c) Explain:

(i) Why the amount of oxygen fell between lines A and B. (03 marks)

Oxygen is a reactant in oxidative phosphorylation; thus started off Krebs cycle & oxidative phosphorylation. Oxygen is final electron and proton acceptor in the process to form water.

(ii) the shape of the trace after time C. (02 marks)

Reduction in concentration of substrates (or being used up); and accumulation of end products (ATP) which led to end product inhibition.

45 (a)(i) Compare the efficiency of air over water as a gaseous exchange medium. (04 marks)

Advantages of air over water as gas exchange media

- Air has a much higher oxygen concentration than water
- Diffusion occurs more quickly so less ventilation of the surface is needed;
- Less energy is needed to move air through the respiratory system than water.

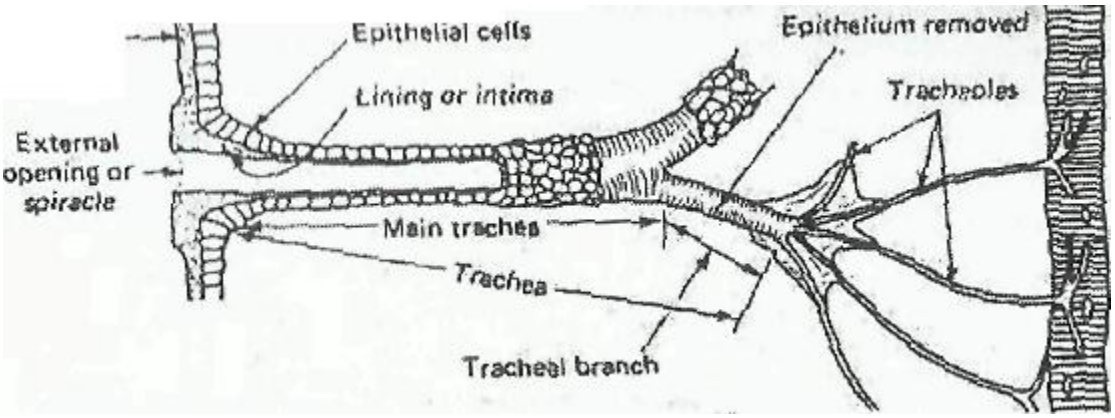
Disadvantage of air as a gas exchange medium

- Water is continuously lost from the gaseous exchange surface by evaporation so the gaseous exchange surface is folded into the body to reduce water loss.

(ii) Give two reasons why mammals need lungs rather than exchanging gases via skin. (02 marks)

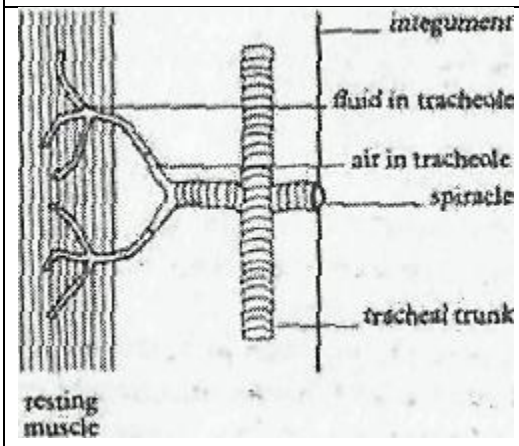
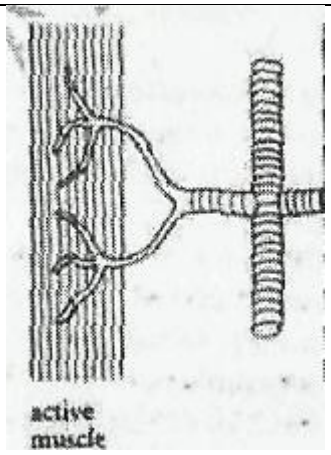
- The skin would not provide n sufficiently large surface area for gaseous exchange
- Gaseous exchange through the skin would result in excessive water loss

b) Describe the tracheal system of an insect. (08 marks)



The tracheal systems of various insects consist of variable pairs of spiracles, located laterally on the body surface. Of these, some arc thoracic and the others arc abdominal. The spiracles are guarded by fine hairs to keep the foreign particles out and by valves that function to open or close the spiracles as required. The spiracles open into small spaces called the atria that continue as air tubes called the tracheae. The tracheae are fine tubes that have a wall of single layered epithelial cells. The cells secrete spiral cuticular thickenings called taenidia around the tube that gives support to the tubes. The tracheal tubes branch further into finer trachea that enter all the tissues and sometimes, even the cells of the insect. The ends of the tracheoles that are in the tissue are filled with fluid and lack the cuticular thickenings. The main tracheal tubes join together to form three main tracheal trunks dorsal, ventral and lateral. At some places, the tracheae enlarge to form air sacs which are devoid of cuticle and serve to store air.

c). How does ventilation and gaseous exchange occur in a terrestrial insect? (08 marks)

Tracheoles with fluid during expiration	Tracheoles without fluid during inspiration
	

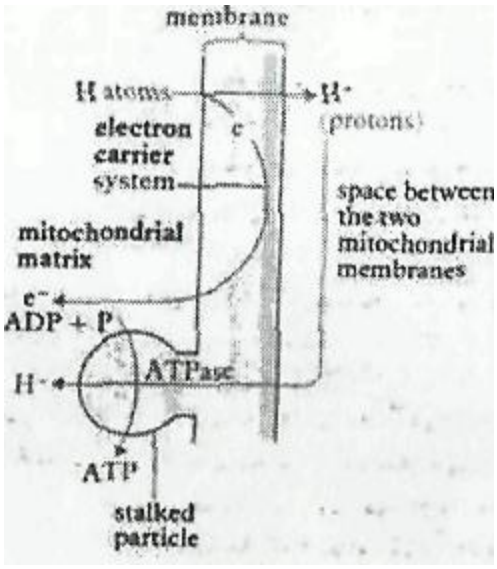
Increased CO: is detected by chemo receptors, causing relaxation of the abdominal muscles and lowering of pressure. The spiracles valves open and air rich in oxygen is drawn into the tracheal system. Spiracles valves then close and oxygen is forced along the tracheal system into the fluid-filled tracheoles, which are in direct contact with the tissue fluid. Gaseous exchange takes place due to difference in concentration gradients of oxygen and carbon dioxide. Air is expelled out when muscles contract and flatten the insect body, decreasing the volume of the tracheal system. During increased metabolic activity, the water potential of tissue lowers causing osmotic efflux of water from the tracheoles; and hence air replaces the fluid of the tracheoles. In resting tissues, the water potential of tissue fluid increases resulting in the diffusion of much water into the tracheoles.

QN 39 (a) what is meant by oxidative decarboxylation? (03 marks)

Is the removal of hydrogen and carbon atoms; from intermediate compounds of carbohydrate metabolism substrates; in the matrix of mitochondria to form carbon dioxide from oxidation of carbon atoms by oxygen and $NADH_2$.

b) Explain the mechanisms leading to formation of ATP that occurs involving the inner mitochondrial membrane. (10 marks)

H atoms in the mitochondrial matrix dissociate into protons and electrons; using energy from electron transport chain; the protons are actively pumped; from the matrix across the inner membrane into the intermembrane space; using energy derived from hydrolysis of ATP in the electron transport chain; this creates an electrochemical proton gradient between the matrix and inter-membrane space of the mitochondria; Protons then diffuse back to the matrix across the inner membrane down a concentration gradient; through specific channels with stalked granules /particles where ATPase enzyme; is used to combine ADP with inorganic phosphate to form ATP; using energy released by the protons;



c) Describe the respiratory metabolism of glycerol in the cytoplasm of the cell. (07 marks)

Glycerol is phosphorylated to glycerol-3-phospante and hydrolysis of ATP to ADP which provides phosphate and energy for the process; the glycerol-3-phosphate is then oxidized by NAD to form $NADH_2$ and phoshoglyceraldehyde interchangeable with dihydroxyacetone then fed into the glycolytic pathway. 3-phosphoglyccraldehydc is then phosphorylated using an inorganic phosphate and oxidized by NAD^+ to form $NADH_2$ and glycerate-1, 3-biphosphate; Each glycerate-l, 3-biphosphate loses phosphate; molecules to form ATP from ADP; glycerate-3-phosphate formed is further dehydrated (loses water molecule) forming ATP and pyruvate; Pyruvate is then taken into the mitochondrial matrix for further production of energy in the Krebs cycle. The formed $NADH_2$& $FADH_2$ is fed into the electron transport chain generating more ATP;

QN 40 (a) Describe the structure and modifications of the features of the mitochondrion that suits their functions.

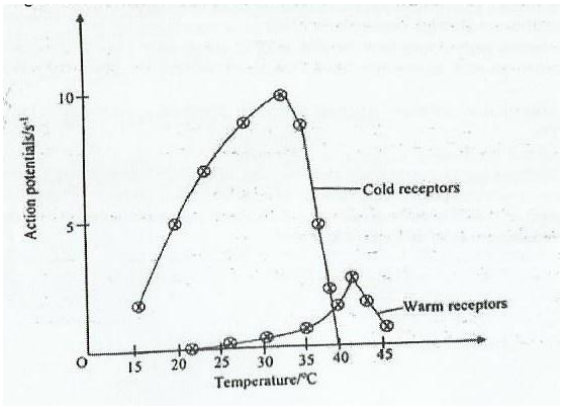
- Inner membrane is highly folded to increase surface area for respiratory activity
- Outer membrane is thin to allow passage of materials in and out of mitochondria.
- Compartments between inner and outer membranes with space to contain protons;
- Stalked granules with chemi-osmotic channels arranged at different energy levels for passage of protons where in the process energy is emitted for phosphorylation;
- Inner membrane contains protein molecules that actively pump protons into the inter-membranal spaces
- Jelly like matrix; containing enzymes that catalyze ADP and Pi combination to form ATP
- Ribosomes and circular DNA in the matrix for protein synthesis;
- Phosphate granules providing phosphate units that combines with ADP to form ATP.

b) Explain mechanisms which lead to formation of ATP molecules that occurs involving inner membrane of the mitochondrion. (14 marks)

Hydrogen atoms is first accepted by a hydrogen acceptor NAD at a higher energy level; to form reduced NAD ($NADH_2$) reduced NAD losses the hydrogen to second hydrogen acceptor FAD at a lower energy level to form reduced FAD ($FADH_2$); energy emitted; is used to combine ADP with a phosphate unit to form adenosine phosphate (ATP); reduced FAD losses its hydrogen atoms to a co-enzyme Q to form reduced Q (Co-enzyme QH_2); the hydrogen atoms dissociate into protons and electrons; The electrons arc carried via chains of electron carrier systems placed at different energy levels; energy is emitted and used for synthesis of ATP molecules. The protons are actively pumped into the compartments between the inner and outer membranes; the protons accumulate until a steep proton gradient exists; the inner membrane is impermeable to protons and protons diffuse rapidly only via the chemi-osmotic channels in the stalked granules at different energy levels; the energy emitted is used for the synthesis of ATP molecules;

HOMEOSTASIS EXCRETION, OSMOREGULATION & TEMPERATURE REGULATION

QN 41 . **An experiment was conducted to measure action potentials generated by cold and warm receptors found in the skin of a mammal. Study the figure below and answer the questions that follow.**



a) Describe the response of the receptors with change in temperature. (05 marks)

(i) Cold receptors (05 marks)

From 15°C to 23°C, increase in temperature cause a rapid increase in action potentials; From 23^0C to 33°C; increase in temperature causes gradual increase in action potential up a maximum of 10 action potentials per second. From 33°C to 35°C, there is a gradual decrease in action potentials. From 35°C to 40°C, further increase in temperature causes a rapid decrease in action potentials; up to a minimum of 0 action potentials per second.

(ii) Warm receptors (04 marks)

Initially at 21°C, the action potential is zero. From 21°C to 35°C; the increase in temperature causes gradual increase in action potentials. From 35°C to 42°C; increase in temperature causes rapid increase in action potential up to a maximum. From 42°C to 46°C; increase in temperature cause a rapid decrease in action potentials to a minimum of action potential per second.

b) Explain the response of the receptors to changing temperature

(i) Cold receptors (08 marks)

Between 15°C to 23°C, increase in temperature (stimulus) increases the number of action potentials fired; because many cold receptors ace stimulated as they have a low threshold value; many enzyme are activated and there is faster diffusion. Between 23°C to 32°C, increase in temperature (stimulus intensity) increases number of action potentials gradually because some of the receptors are adapted; thus few ones firing off action potentials. Between 32°C, there is decrease in the number of action potentials generated. Action potential generation is an enzyme controlled reaction; the optimum temperature for enzymes in the cold receptors is around 32°C beyond which the enzymes are denatured; thus the gradual decrease occurs as few receptor enzymes are denatured. Beyond 35°C, more receptor enzymes art; denatured; thus a rapid decrease in the number of action potential.

(ii) Warm receptors (08 marks)

Between 20°C to 35°C, there is a gradual increase in the number of action potentials by the warm receptors because few receptors are stimulated; as their threshold is high. Between 35°C to 42°C, the rapid increase in action potentials is due to increase in temperature which activates more- enzymes; thus increasing diffusion of ions. Beyond 42°C, the optimum temperature for warm receptor enzymes is exceeded; the number of action potentials decreases due to denaturation of enzymes.

c) Suggest how the response of the receptors would vary with changing temperature if;

(i) The organism was sprayed with water before the experiment. (05 marks)

In both receptors, initially no action potentials would be fired because temperature is below threshold as temperature increases; water on the surface of the organism evaporates cooling the animal. Once water completely evaporates, die body would gain heat; and both receptors are stimulated. Eventually both receptors would get adapted. Cold receptors get easily adapted; than -warm receptors.

(ii) The organism was given iced water before the experiment. (04 marks)

Pattern of action potentials would be the same; as in the graph; iced water has no effect on both receptors since they are found on the skin. Iced water only affects thermo receptors in the hypothalamus.

d) Outline the responses of mammals towards increasing environmental temperature. (04 marks)

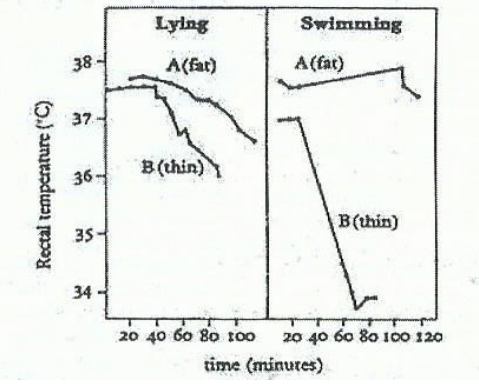
Physiological responses	Behavioral responses
• Sweating/ panting • Relaxation of erector pili muscles/ falling of hairs. • Vasodilation • Reduction in metabolic rate • Increase in body surface area (lying Stretched out) • Decreased muscular activity	• Desire to consume cold food/ drinks • Cold bath/ swimming • Aestivation

e) State the advantages of endotherms over ectotherms. (05 marks)

- Enzyme controlled reactions proceed more efficiently since an optimum temperature is provided.
- Metabolic rate is higher and allows greater activity and faster response to stimuli.
- Can live in a wide range of temperatures; hence can live in a wide range of habitats;
- Can move long distances;
- Can easily obtain food since they are always active;
- Young ones have higher survival rate since they are born active;

QN 42. Figure 1 below shows the results of an experiment on the body temperature of two human subjects, A and B. A is fat whereas B is thin, both subjects had their body temperature

recorded at intervals while immersed in water at C. Results obtained first with the subjects lying still and then while the subjects were swimming.



a)(i) From the figure above, state any two factors that affect body's ability to regulate body temperature of an individual. (02 marks)

- Thickness of the body's subcutaneous fat/ body surface area to volume ratio
- Body activity/ dynamic exercise of the subject in cold water.

(ii) Describe the effect of change in each of the factors above on the rectal temperature.

Effect of thickness of subcutaneous body fat in subjects;

Lying stationary in cold water

Thick subcutaneous fat of a fatty subject lying in cold water generally result in a gradual decrease in rectal temperature as time increases. Thin subcutaneous fat of a thin subject lying in cold water generally result in rapid decrease in rectal temperature as time increases.

Swimming in cold water

Thick subcutaneous fat of a fatly subject swimming in cold water generally results in a gradual increase in rectal temperature as time increases. Thin, subcutaneous fat of a thin subject swimming in cold water generally results in a rapid decrease in rectal temperature as time increases.

Effect of body activity/dynamic exercise in cold water on the rectal temperature of

Fatty subjects

Lying of a fatly subject in cold water generally results in gradual decrease in rectal temperature as time increases. Swimming of a fatty subject in cold water generally results in a gradual increase in rectal temperature as time increases;

Thin subjects

Lying of a thin subject in cold water generally results in gradual decrease in rectal temperature as time increases. Swimming of thin subject in cold water generally results in rapid decrease in rectal temperature as time increases;

(iii) Give an explanation for the results described in a(ii) above. (15 marks)

Subjects lying in cold water are subjected to a constant temperature gradient; and thermal insulation predominantly depends on thickness of the subcutaneous fat layer; A fatty subject, due to small surface area to volume ratio is conferred greater insulation against heat loss; has lower thermal conductivity from the skin & other subcutaneous tissues; conductive heal loss from (lie body thus occurs at a slower rate; accounting for the gradual decrease in rectal temperature. Thin subjects lying in cold water due their large surface area to volume ratio; are offered minimal insulation against heat loss; lose heat at a faster rate; accounting for the rapid decrease in their rectal temperature; Swimming subjects are subjected to an increasing temperature gradient; sufficient thermoregulation is thus achieved by both the insulative effect of the subcutaneous fat layer and intrinsic heat production; Swimming is associated with a raised metabolic rate; and hence increased heat production; Such heat production augments the insulative effect of the subcutaneous fat in a swimming fatty subject and this exceeds conductive heat loss causing a general gradual rise in rectal temperature when the subject is swimming. For a swimming thin subject, conductive heat loss far much exceeds heat conserved by insulation and that generated intrinsically through raised metabolism; rectal temperature thus generally decreases rapidly;

b) Explain;

(i) Why rectal temperature and not skin temperature was used in the experiment. (04 marks)

Rectum, unlike the skin, is very highly vascular; and provides the most closed cavity; that limits heat exchanges between the body and the surrounding; thus provide the most accurate measurement of body temperature approximating the core body temperatures; Skin temperature, unlike rectal temperature significantly varies in different parts of the body;

(ii) The effect of increasing water temperature to 25^0C. (03 marks)

Increasing water temperature to 25°C proportionally slows down the rate of reduction in rectal temperature of both subjects; Increasing water temperature to 25°C reduces the temperature gradient between the body and the surrounding water; The surrounding temperature being still lower than the body temperature prompts heat loss to the surrounding but at a slower rate;

(iii) Why prolonged exposure to severe cold of the living cell at the tips of the finger may die? (02 marks)

Finger tips, due to their large surface area to volume ratio and poor thermal insulation; are subjected to extensive heat loss once exposed to severe cold; Compensatory onset of vasoconstriction slows down flow of warm blood from the core of the body to the finger tips; and prolonged exposure to cold eventually leads to formation of ice crystals in tissues; that cause cellular damage and death (frost bite injuries);

c) State the structural and physiological changes that occurred in the body of the thin human throughout the time of experiment.

Structural changes	Physiological changes
• Erection of the skin hairs	• Cutaneous vasoconstriction • Shivering thermogenesis • Dilation of the shunt vessels • Contraction of the erector pilli muscles • Elevated basal metabolic rate • Increased muscular activity • Inhibition of swearing

d) How can thin bodied organisms survive in conditions of low temperature? (03 marks)

- Insulative acclimatization through development of fur or subcutaneous fat.
- Metabolic adjustments such as long term increase in basal metabolism, brown fat metabolism
- Habituative adaptations such as long term change in blood flow patterns inform of persistent superficial vasoconstriction.
- Behavioral acclimatization in form of seasonal migration, hibernation, sun bathing, basking, burrowing in warm areas, etc.

25(a) Explain the significance of excretion in living organisms. (02 marks)

- Enables removal of toxic products of metabolism; maintaining the body's steady state/equilibrium.
- Removes toxic wastes that if accumulated would affect the metabolic activities of organisms e.g. may act as enzyme inhibitors

b) Outline some of the excretory products in plants. (05 marks)

- Carbon dioxide, Water and Oxygen from respiration and photosynthesis respectively.
- Anthocyanins stored in petals, leaves, fruits, barks.
- Tannins deposited in dead tree tissues like wood and barks
- Calcium oxalates, calcium carbonates and Latex (rubber)
- Alkaloids like quinine, cannabis, cocaine, caffeine, morphine etc.

c) Explain why plants lack complex/ elaborate excretory systems as those seen in animals?

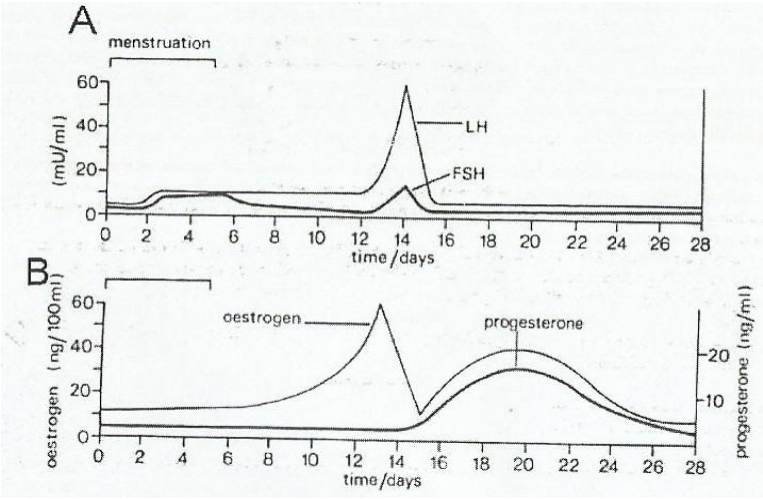
(13 marks)

- Toxic wastes do not accumulate because they are utilized by the plant e.g CO_2 arid water are raw materials for photosynthesis while oxygen participates in respiration.
- Extra gaseous wastes are removed from plant bodies by simple diffusion through the stomata and lenticels.

- Most of the organic waste substances formed in plants are non-harmful and can be stored in the plant tissues which are removed periodically e.g. leaves and bark.
- Some plants store other wastes such as resins in organs that later fall off e.g. leaves.
- Excess water and dissolved -gases are removed by transpiration through the stomata.
- Some plants remove wastes products by exudation e.g. gum, resins, latex and rubber.
- In some plants guttation occurs i.e. excess water with dissolved salts ooze out through hydathodes at leaf surfaces
- Organic acids which 'would be harmful to plants often combine with excess cations and precipitate as insoluble crystals which can be safely stored in plant cells e.g. excess Ca^{2+} combines with oxalic and pectic acids to form the non-toxic calcium oxalate and calcium pectate.
- Plants synthesize all their organic requirements according to demand, leaving no excess of protein hence very little excretion of nitrogenous waste substances occurs.
- The rate and amount of catabolism is much slower and much less than that of animals, of similar weight, and as a result the waste products accumulate more slowly.

REPRODUCTION

QN 46 . Graph A and B deal with concentration changes, indicating the amounts of hormones present in the blood throughout the cycle.



a) State three general features of animal hormones. (03 marks)

- Secreted by endocrine glands also known as ductless glands.
- They are directly secreted into the blood stream
- Glands of the endocrine system secrete hormones in very minute quantities
- Often the effect of these hormones is at a different site from the site of secretion.
- The action of the hormone is on specific tissue or organs known as target tissues or organs.
- They are known as chemical messengers; they modify and regulate the activity of the target tissues or organs
- Most of the animal hormones are water-soluble and are derived from amino acids, peptides or proteins. These molecules are hydrophilic in nature and large so they cannot pass through the cell membrane. These hormones interact with receptor molecules seen on the surface of the membranes.
- Hormones like the steroid hormones e.g. thyroid hormone arc hydrophobia and they readily diffuse through the cell membranes and bind to receptor inside the cell.

b) Using the two graphs in the figure above, explain the changes in the blood levels of the hormones with time during the cycle.

From day 2 to day 3, concentration of both luteinizing hormone (LH) and follicle stimulating hormones (FSH) increase gradually. Gonadotrophin releasing hormone (GnRH) from the hypothalamus stimulates the anterior pituitary gland to secrete FSH and LH. FSH stimulates the growth and development of the graafian follicles in the ovaries wall of the ovaries or theca start secreting oestrogen thus its concentration increase gradually between day 6 and day 13 reaching maximum on day 13. Increased oestrogen levels inhibit secretion of FSH. Decreasing FSH concentration rapidly between day 6 and day 7; then gradually between day 7 & day 1*2:* but has little effect on the secretion of LH from the anterior pituitary gland it, thus its concentration remaining constant between day 3 and day 12. Peaking of oestrogen on day 13 triggers a sudden surge in the production of both FSH and LH; their concentrations increasing rapidly to the maximum between day 13 and day 14; LH stimulates resumption of meiosis in the primary oocyte to form polar body and secondary oocyte which is released by rupturing of graafian follicle (cause ovulation). Oestrogen concentration decreases rapidly between day 13 and day 15 to a rapid increase in concentration of LH; LH stimulates the remains of the graafian follicle to develop into corpus luteum (yellow body), which secretes progesterone and continues to secrete oestrogen; increasing the concentration of both hormones rapidly between day 15 and day 20; Progesterone causes the uterus to become highly muscular and vascular, and also inhibits the release of LH and FSH; decreasing their concentration rapidly

between day 14 and day 15; The failure of oocyte fertilization also causes degeneration of the corpus luteum, which results in gradual decreased levels of oestrogen and progesterone.

c) Basing on the effects of each of the hormones on the secretion of others, show how negative feedback operates in the human menstrual cycle.

The hypothalamic Gonadotrophin-releasing hormone (GnRH) stimulates the anterior pituitary to secrete both FSH and LH; FSH stimulates the secretion of oestrogen in the ovary. Increased levels of oestrogen inhibit FSH secretion and causes secretion of LH from the anterior pituitary. LH stimulates ovulation and development of corpus luteum, which secretes progesterone and also continues to secrete oestrogen. Progesterone inhibits the release of LH and FSH preventing development of any further follicles.

d) Suggest what would be the effect on the blood level of the hormones if;

(i) The ovary of the human is surgically removed

Levels of oestrogen drastically reduce; Levels of gonadotrophins (FSH and LH) rise by negative feedback.

(ii) Successful fertilization occurred

Progesterone & oestrogen levels rise; levels of FSH and LH reduce; preventing further maturation of graafian follicles and ovulation respectively.

e) Explain how use of each of the following may affect the blood levels of the hormones in the figure above

(i) Contraceptive pills

Adds more oestrogen and progesterone maintaining high levels of the hormones in blood which inhibits production of Gonadotrophin hormones from the pituitary glands

(ii) Fertility drugs

Inhibits negative feedback mechanisms of oestrogen (reduces oestrogen levels) in the hypothalamus & pituitary gland which stimulates the secretion of pituitary's gonadotrophic hormones (increasing levels of FSH and LH)

g) State the factors that affect breeding cycles of animals.

- Temperature
- Humidity
- Day length
- Life expectancy
- Genotype

- Food availability
- Testosterone concentration

h) How is courtship of significance in reproduction of organisms?

- Attracts a male possibly from a considerable distance often by conspicuously noisy behaviors
- Drives away other mates competing for the female at oestrus
- Ensures mating occurs between members of the same species and between sexually fit and healthy individuals
- Synchronizes the activities of both partners for successful copulation
- Induces a comparable level of sexual arousal in both partners making both equally ready and willing to copulate.

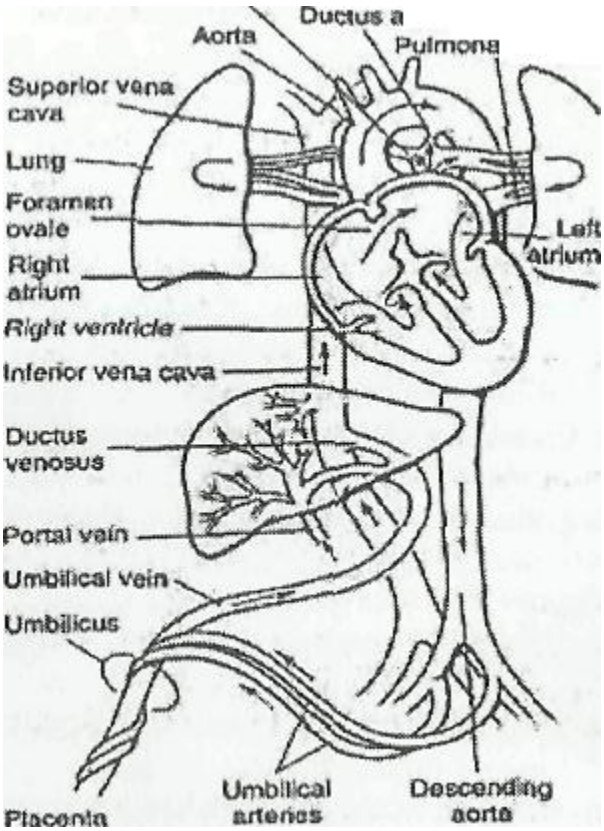
QN 47(a) Describe how the structure of the placenta is adapted to function. (10 marks)

- Closeness of maternal and foetal blood vessels facilitates faster diffusion of substances.
- Chorionic villi cells contain numerous mitochondria to provide energy required for active transport
- Numerous chorionic villi, increase surface area for absorption of materials; exchange of gases.
- Two umbilical arteries; transport blood containing wastes from foetus to mother's blood for excretion
- Umbilical vein; transport nutrient and oxygen rich blood from the mother to the foetus
- Numerous maternal arterioles; supply oxygen and nutrient rich blood to foetus
- Syncytiotrophoblast (syncytium); secretes HCG; important in barrier functions of the placenta
- Numerous glandular tissues; secrete placental oestrogen, progesterone, HCG; important in maintaining the well-being of the fetus.
- Numerous maternal venules into which fetal blood containing wastes drains to be transported back to maternal blood for excretion

- Decidualised arterioles and arteries i.e. remodeled such that they are less convoluted and are of increased luminal diameter; increase maternal blood flow to the placenta; create steep concentration gradient; allowing efficient material exchange.
- Endometrium breaks down in the region of the villi; so that placental villi may be bathed in maternal blood; making exchange more efficient but still keeping the fetal and maternal blood separate.
- Chorionic arteries; divide to cotyledon arteries; further divided to from a dense arterio-capillary venous system creates a steep concentration gradient allowing efficient material transport and exchange
- Selectively permeable placental barrier/membrane; allows selective diffusion of antibodies for passive immunity hormone diffusion; barrier also impedes microbes from accessing the foetus

b) Describe the fetal circulation changes that immediately after birth. (10 marks)

Immediately after birth, gaseous exchange begins in baby's lungs; cutting the umbilical cord switches off placental circulation; Fetal heart shunts gel closed; At birth, activation of breathing in the baby's lungs cause them to get distended; capillary network in the lungs get dilate allowing rich blood flow to the alveoli. Pressure in the right atrium sinks below that in the left atrium; foramen primum flaps over foramen secundum causing closure of foramen ovale; Cutting the umbilical cord; placental resistance cease; systemic peripheral resistance increase pressure in the aorta exceeds that in the pulmonary trunk; right left shunt becomes left-right shunt; increase in oxygen pressure within the aorta; causes contraction of the smooth musculature of walls of the ductus arteriosus causing its closure. Umbilical arteries and vein begin obliterating; more blood begins flowing lo the kidney's and gut since they’ve become functional. Finally blood flows to the right atrium; then to the right ventricle to lungs and back to ill for systemic circulation.



QN 48(a) Outline the causes of infertility and how they can be treated. (15 marks)

Causes of infertility

- Ovulatory disorders which can be hormonal, endocrine or by emotional stress.
- An ovulatory ovarian disorders like polycystic ovarian disorders.
- An ovulatory thyroid disorders like hyperthyroidic or hypothyroidic states.
- Chromosomal disorders
- Tubal dysfunction caused by pelvic inflammatory diseases
- Hormonal imbalances
- High vaginal acidity
- Thick cervical mucus impenetrable by sperms
- Cervical infections; cause recruitment of spermicide macrophages
- Uterine-abnormalities like absent uterus, uterine fibroids and endometriosis
- Impaired spermatogenesis (malformed sperms, low sperm count)
- Impaired spermatic transport like Epididymal malformations in males.
- Ejaculatory dysfunctions inform of an ejaculation, premature ejaculation
- Exposure to ionizing radiations, mutagens and chemical agents like drugs
- Autoimmune response; body mistakenly fights its ovarian tissues.

- Excessive overweight or underweight can disrupt the pattern of FSH and LH secretion.
- Too much prolactin secretion which reduces oestrogen production and may cause infertility.
- Implantation failure due to fibroids/tumors, inflammation, uterine congenital anomalies

Treatment of infertility

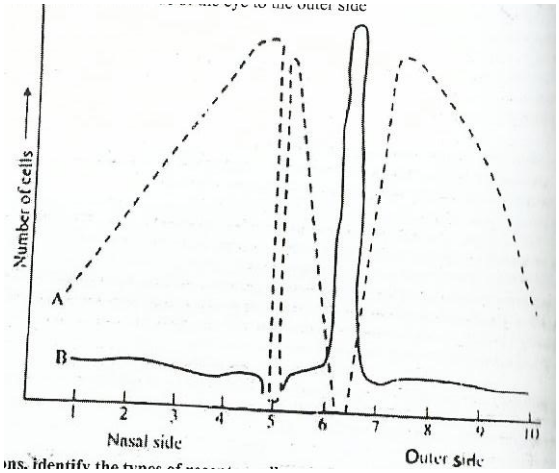
- Hormonal therapy for an ovulatory disorders; by giving ovulatory agents like clomiphene, hCG analogue
- Salpingolysis, Salpingostomy and tubal anastomosis for tubal disorders
- In vitro fertilization (IVF)
- Intracytoplasmic sperm injection
- Zygote Intra fallopian transfer
- Gamete Intra fallopian transfer
- Intra-uterine insemination
- Ovum/ ova donation
- Surrogacy
- Prevention of STDs

b) State the preventive measures against infertility. (05 marks)

- Avoiding illicit drug use, tobacco use or excessive alcohol consumption.
- Avoiding exposure to industrial or environmental toxins
- Limit medications that can impact fertility
- Exercise regularly, eat balanced diet
- Limiting exposure to ionizing radiations.

COORDINATION

QN 50 **. The graph below shows the number of receptor cells (type A and B) in arbitrary units in the human retina along a horizontal line from the nasal side of the eye to the outer side**



a)(**i) Giving reasons, identify the types of receptor cells represented by A and B. (02 marks)**

Receptor cells A represent rods; no concentration at 6.3; / no concentration of fovea. Receptor cell represent cones; highest concentration at 6.3; / highest concentration of fovea.

(ii) Explain why there are no receptor cells at position 5. (04 marks)

Position 5 where there are no receptor cells is called the blind spot; neurons from the rods and cones pass in front of the retina where they converge to form the optic nerve; they are so densely packed that no receptor cells occur.

(iii) What is the name of the region of the retina at position 6.3? Give a reason for your answer. (01 marks)

Fovea/ fovea centralis/ yellow spot;
Has highest concentration of cones/ lacks receptor cells A (rods);

b) Explain why;

(i) the greatest concentration of receptor cells type B occurs at position 6.3. (03 marks)

For the large concentration of receptor cells of type B (cones) at position 6.3 is that it lies on the optical axis directly opposite the center of the lens; it is here that the greatest refraction of light waves occurs; when a person is looking directly at an object; Type B receptor cells (cones) are sensitive to high light intensities hence their high concentration where the light intensity is greater (i.e. at the force);

(ii) On entering a dimly-lit mom, objects in the room at first are invisible but gradually become visible.

In bright surrounding circular muscles are contracted and the pupil is constricted; this reduces the amount of light entering the eye; and reduces over stimulation of the cone cells; on

entering a dimly lit room the radial muscles of the iris contract and the pupil slowly dilates to allow the maximum amount of light to enter the eye; the process takes a little time during which so little light enters the eye that the threshold value for stimulating the rod (which are sensitive to light of low intensity) is not reached and so nothing can be seen as the pupil dilates fully such that the threshold value for rods is reached and objects become visible;

(iii) In a dimly-lit room, objects are only visible in black and white colors. (02 marks)

The rods however do not respond to light of various wavelengths in the same way that three types of cone cell do; for this reason objects in the dimly-lit room are visible only in black and white;

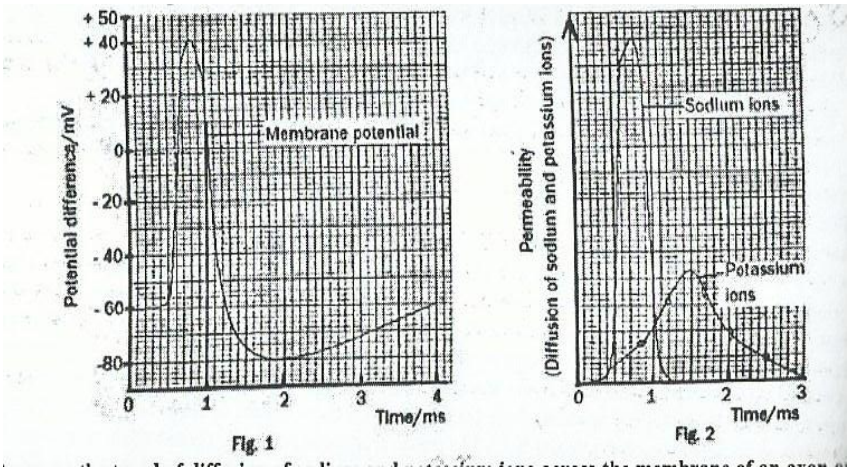
c)(i) From the graph, identify and describe the features of the receptor cells which allow color vision.

- Highly concentrated at 6.3 concentration at 5
- Low concentration at 5
- Evenly distributed between 1 to 4.8 and 7 to 10
- Increase rapidly between 6 to 6.3 and decrease rapidly between 6.3 to 7

(ii) The flowers of three species of a plant are similar in form and appear to have yellow colors of petals. When photographed in ultraviolet light, each species shows a different pattern on its petals. Using this information, explain how bees are able to distinguish between the flowers of the three species, but not humans.

Ultraviolet light comprises a range of wave lengths; in much the same way that visible light docs; The cone cells of humans cannot distinguish different ultra violet wavelengths and the light from the petals stimulates the red & the green cones, uniformly giving the appearance of yellow; In bees, the rhabdom of their compound eyes can distinguish different wavelengths of ultraviolet light; The petals must have pattern of pigment that reflects the different ultraviolet light differently. The different wavelengths reflected produce a pattern when perceived by bees. In each species the pattern must vary, allowing the bees to distinguish the wavelengths;

QN 51 . Figure 1 below shows the changes in the membrane potential showing the electrical events associated with the nerve impulse in the axon while figure 2 shows changes in the permeability of the membrane of the axon to sodium and potassium ions during transmission of an impulse which occurs very fast and rapidly.



a) Compare the trend of diffusion of sodium and potassium ions across the membrane of an axon over a 3 milliseconds (ms) period. (08 marks)

Similarities

- In both, diffusion of sodium and potassium ions increase rapidly to the maximum
- In both diffusion of sodium ions and potassium ions reach the maximum /peak;
- In both sodium ions and potassium ions diffusion decline rapidly after the peak;
- In both diffusion of sodium and potassium ions begin to increase from0.2ins;
- In both diffusion of sodium ions and potassium ions is the same at 10ms

Differences

- Diffusion of sodium ions are higher while that of potassium ions are lower between 0.4ms and 1ms.
- Diffusion of sodium ions is lower while the diffusion of potassium ions is higher between 1 and 1.2ms;
- Diffusion of sodium ions decrease rapidly while diffusion of K^+ increase rapidly between 0.8 and 1.4ms
- Diffusion of sodium ions increase more rapidly than diffusion of potassium ions from 0.4ms to 0.8ms.

- Maximum diffusion of sodium ions was reached at an earlier time; while maximum diffusion of K^+reached at later time of 1.5ms;
- Diffusion of K^+increases between 1.3 to 1.5ms & decline rapidly up to 3.0ms while diffusion of Na^+cease.

b) Using both figures 1 and 2, explain the trend of each of the following during the propagation of the impulse in the axon,

(i) Membrane potential

Between 0 and 0 4ms, the negative membrane potential is kept constant at -60mV; this is a resting potential, the outside of the membrane of an axon is more positive while the inside is more negative/ membrane is polarized. Between 0.4ms and 0.6ms the negative potential difference decreased rapidly to zero/ potential difference rapidly becoming less negative; this is because the outside of the membrane is building a slightly negative charges while the inside is building a slightly positive charges; Between 0.6ms and 0.85ms, positive potential difference increased rapidly to reach a peak at +40mV; this is because the outside of a membrane has attained a more negative charge while the inside attained n more positive charges/ membrane is more depolarized; a threshold value is attained at the peak, resulting into action potential/transmission of impulses. Between 0.85ms and 1,0ms, positive potential difference declined rapidly because the outside of the membrane is once again becoming slightly positive while the inside is becoming slightly negative/membrane is slightly repolarized. Between 1ms and 1.2ms the negative potential difference increased rapidly to 60mV/ resting potential/ potential rapidly becomes more negative; the -hide of the membrane is more positive while the inside is more negative.' the membrane is repolarized; Between 1.2ms and 1.8ms; the negative potential difference increases beyond the negative resting potential/ potential difference is more negative than the resting potential; this is because the membrane is hyperpolarized; Between 2ms and 4ms the negative potential difference decreased gradually/potential difference becomes gradually less negative to attain a resting potential; membrane of the axon is fully repolarized;

(ii) Sodium ions

Between 0 and 0.3ms, diffusion of sodium ions remained constant; this is because there is net diffusion of sodium ions; sodium gates are closed/protein channels specific to sodium ions are closed; Between 0.3ms and 0.8ms diffusion of sodium ions increase more rapidly, there is stimulus; sodium gates/ protein channels specific to Na^+ ions open, sodium ions diffuse rapidly inside the membrane. Between 0.8ms &1.2 ms, sodium ions diffusion decline rapidly; because an impulse has already been transmitted and sodium gates close.

(iii) Potassium ions

Between 0.4ms and 1.5ms the potassium ions diffusion increase rapidly; action potential has already been achieved and many protein channels specific to potassium ions open; potassium ions diffuse rapidly outside the membrane. Between 1.5ms and 3ms the potassium ions diffusion decline rapidly, the membrane is becomes impermeable to outward diffusion of potassium ions/protein channels specific to potassium ions close and potassium ions do not diffuse rapidly outside.

c) In each case, state two factors which can cause rapid and slow propagation of impulses. (06 marks)

Rapid propagation of impulses caused by;

- Myelination of membrane of an axon.
- Larger diameter of the axon.
- High body temperatures/ endotherm;
- Adequate/ high concentrations of sodium/ potassium ions in the body

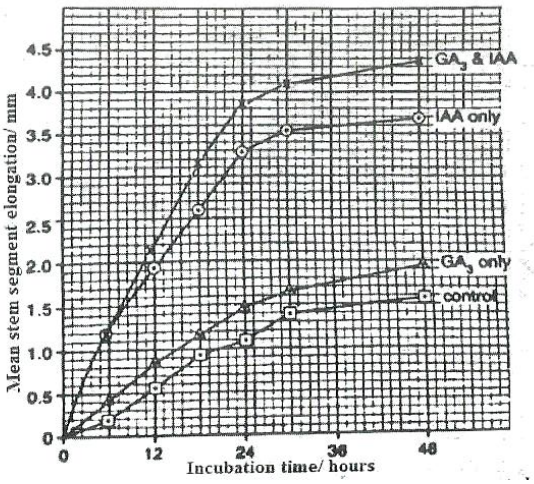
Slow propagation of impulses caused by;

- Non-myelination of membrane of an axon
- Smaller diameter of the axon;
- Low body temperatures;
- Low concentration of mineral ions

d) Give the significance of fast conduction of impulses to organisms. (04 marks)

- Quick/ fast detection and escape responses from predators and danger;
- Fust detection of sudden changes in external and internal environments
- Homeostatic control mechanisms are achieved fast and easily;
- Fast stimulation of glands to secrete digestive enzymes resulting into fast digestion
- Fast responses due to fast secretion of hormones;

QN 52 . An experiment was carried out to investigate the effect of an auxin/ indole-acetic acid (IAA) and gibberellic acid (GA_3) on the elongation of segments of pea stem. A control group of pea segments received on added IAA or GA_3. Other groups of pea segments were treated with equivalent quantities of IAA only, GA_3 only or both IAA or GA_3.



a) Describe the effect of each of the following plant hormones on mean stem segment elongation

(i) Gibberellic acid GA_3. (03 marks)

Increases mean segment elongation slightly rapidly increasing mean stem elongation in 24 hours & later gradually

(ii) Indoleacetic acid (IAA). (03 marks)

Increases mean stern segment elongation greatly/ rapidly increasing within 24 hours and later gradually increasing

b)(i) With reason, state the biological relationship exhibited by gibberellins and IAA. (03 marks)

Synergism; their combined effect is much greater than the sum of their separate effect

(ii) Explain the difference in the effect on the mean stem segment elongation when the pea plants were treated with IAA only and when treated with a mixture of IAA or GA_3. (03 marks)

Mixture of IAA and GA_3 has a greater effect on mean stem segment elongation than when IAA was used only. In the mixture GA_3 initiates the formation of IAA; more IAA is secreted on addition to already added weakening the cell walls faster allowing greater elongation of the stem together.

c) Describe the role of GA_3 in seed germination. (08 marks)

Once released by the hydrated embryo following imbibition and in consequent trans local ion to the aleurone layer of the seed, gibberellic acid hydrolytic enzymes like carbohydrases like amylase, protease, lipase which on being-transported to the food reserves catalyzes hydrolysis of stored food substance .to suitable food substances which are translocated to die embryo for respiration to provide energy for germination amino acids from protein hydrolysis used to synthesize enzymes and tissue, lipids for formation of other growth substances in the embryo which brings about seed germination

d) How have farmers used IAA to their benefits? (04 marks)

- They have been used as selective weed killers
- Induction of fruiting in the absence of pollination (parthenocarpy);
- Used in storage of potatoes or other crops since they inhibit sprouting / prolong seed dormancy
- Synthetic auxins utilized as rooting agents on stem cuttings and for development of adventitious roots.
- Auxins are utilized as anti-abscission agents; preventing premature leaf and fruit fall
- Auxins have been used to delay flowering until an appropriate time.
- Auxins have been used increase fruit size.
- Auxins are utilized as anti-sprouting agents in potatoes; prolonging their storage time

QN 55 (a) Describe how a nerve impulse crosses a cholinergic synapse. (05 marks)

When the action potential arrives at the presynaptic knob; it causes calcium ion channels to open. Calcium ions flood into the neurone down their concentration gradient. The knob contains winy tiny vesicles full of the neurotransmitter acetylcholine. The calcium ions make these vesicles move to the presynaptic membrane and fuse with it; releasing the acetylcholine into the synaptic cleft. This cleft is very small, so it takes only a millisecond or two for the acetylcholine to diffuse across it. On the other side of the cleft, there are receptor molecules in the postsynaptic membrane and the acetylcholine molecules fit perfectly into these. This makes sodium ion channels in the postsynaptic membrane open; so sodium ions flood in down their concentration gradient. This depolarizes the membrane; (gives it a positive charge inside) which sets up an action potential in the postsynaptic neurone.

b) Explain the functions of a sensory neurone and a motor neurone in a reflex arc. (15 marks)

A sensory neurone has its cell body in the ganglion in the dorsal root of a spinal nerve. It has a very long dendron that carries action potentials from a receptor towards its cell body and a shorter axon that carries the action potentials into the spinal cord (or brain). The ending of the

dendron may be within a specialized receptor such as a Pacinian corpuscle in the skin. Pressure acting on the Pacinian corpuscle depolarizes the membrane of the dendron & generates an action potential.

The motor neurone has its cell body within the central nervous system (in the brain or the spinal cord). It has many short dendrites and a long axon. It will have many synapses, including several with sensory neurones. Thus the action potential from a sensory neurone can cross the synapse and set up an action potential in the motor neurone which will then transmit it to an effector such as a muscle or gland. The action potential then causes the effector to respond, for example; by contracting (if it is a muscle).

In a reflex are, the impulses travel directly from the sensory to the motor neurone (or sometimes via an intermediate neurone between them) without having to be processed in the brain. This means the pathway from receptor to effector is as short as possible, so the response can happen very quickly.

IMMUNITY & IMMUNE SYSTEM

32(a) How is the structure of the plasma membrane related to function? (08 marks)

- Glycoproteins work as antigens in immunity.
- Channel proteins allow diffusion of polar ions and molecules across the membrane.
- Some membrane proteins have enzymatic properties e.g. ATP synthase tor ATP synthesis,
- Some membrane proteins work as electron carriers in electron transport chains,
- Glycolipids are involved in cell-to-cell recognition.
- Cholesterol stabilizes membrane structure by preventing phospholipids from closely packing together.
- Lipid bi-layer, being semi-permeable, it controls movement of substances in and out of the cell.
- Membrane proteins provide sites for cytoskeleton filaments to anchor to support and maintain cell shape
- Membrane proteins join cells together forming tissues which perform specific functions.
- Transport proteins move ions or solutes by active transport e.g. sodium ions or by facilitate diffusion e.g. glucose, amino acids across the membrane
- Glyco proteins arc involved in cell-to-cell recognition by cells of complimentary sites e.g. specific hormones
- Cell surface receptor proteins are involved in signal-transduction by convening an extracellular signal to an intracellular one.

b) Explain the factors that affect the fluidity of the plasma membrane. (10 marks)

Temperature; Low temperature decreases membrane fluidity because lipids are laterally ordered, the lipid chains pack well together, mobility reduces to allow many stabilizing interactions. Increase in temperature increases membrane fluidity because lipids acquire thermal energy to become mobile and reduce stabilizing interactions.

Length of lipid tails; Lipids with shorter chains are more fluid because they quickly gain kinetic energy due to their smaller molecular size and have less surface area for Vander Waals interactions to stabilize with neighboring hydrophobic chains. Lipids with longer chains are le-fluid because their large surface area enables more Vander Waals interactions hence increasing the melting temperature.

Lipid saturation; Lipid chains with double bonds (unsaturated fatty acids) are more fluid because the kinks caused by double bonds make ii harder for the lipids to pack together Lipids that have single bonds (saturated fatty acids) have straightened hydrocarbon chain which pack together to reduce membrane fluidity.

Presence of cholesterol; At low temperatures, cholesterol increases membrane fluidity by preventing fatty acid hydrocarbon chains from coming together and crystallizing there by inhibiting the transition from liquid to solid (decreases the membrane freezing point). At warm temperature (e.g. 37^0C) cholesterol decreases membrane fluidity by interacting with lipid tails to reduce their morality, thereby increasing the melting point. At high concentrations cholesterol also prevents fatty acid hydrocarbon chains from coming together and crystallizing.

c) Outline the importance of regulating membrane fluidity. (02 marks)

- Membranes must be fluid to work properly by ensuring flexibility.
- Biological processes stop when bi-layer fluidity reduces so much e.g. membrane transport & enzyme activities.

CHEMICAL OF LIFE

QN 9 (a) State the comparisons between translation and transcription. (07 marks)

Similarities

- Both transcription and translation are involved in protein synthesis.
- Messenger RNA (mRNA) plays a central role in both translation and transcription
- Both processes involve reading information encoded on nucleic acids
- Both processes involve enzymatically controlled reactions

Differences

Transcription	Translation

Information is read from the cistron of DNA	Information is encoded on the mRNA from the transcribing strand of DNA
Produces polynucleotide (mRNA) molecules complementary to the transcribing DNA transcript	Produces polypeptides whose base sequence for the amino acid is complementary to mRNA (same as that of DNA)
Occurs in the nucleus	Occurs in the cytoplasm
Primarily involves mRNA as the only active RNA	Involves participation of all the RNA molecules
Post-transcriptional modification involves splicing	Post-translational modifications are mainly
Fewer enzymes (RNA polymerases) are involved	Several enzymes and factors are involved; as three
Involves assemblage of nucleotides	Involves assemblage of amino acids

Binding of mRNA to ribosome; several ribosomes in the cytoplasm attach to mRNA; constitute a polyribosome/ polysome. Each ribosome has a major and minor subunit. Amino acid activation and attachment to tRNA; amino acids in their pool within the cytoplasm get activated by combining with specific tRNA molecules basing on the triplet base sequence of their tRNA anticodon. Process requires energy from ATP hydrolysis and is catalyzed by the enzyme aminoacyl tRNA synthase/ ligase. An aminoacyl tRNA complex is formed. Polypeptide chain initiation; the first two mRNA codons (total of 6 bases), enter the ribosome; first codon (AUG) binds to aminoacyl -tRNA molecule by complementary base pairing. The complex carries the first amino acid methionine).

Chain elongation; the second codon then also attracts an aminoacyl tRNA complex carrying complementary anticodons, complementary base pairing occurs and the two amino acids get linked by means of a peptide bond. The ribosome then moves one codon forward i.e. translocates along the mRNA and a new aminoacyl tRNA complex enters. The process repeats and more amino acids get continuously added to the growing polypeptide chain. The tRNA molecule which was previously attached to the polypeptide chain now leaves the ribosomes and passes back to cytoplasm to be re-converted into a new aminoacyl tRNA molecule. Chain termination; ensues when the stop codons i.e. UAA, UAG and UGA since there are no responding tRNAs to these codons. Polypeptide chain elongation terminates. The proof reading enzymes ascertains right amino acid sequences and the protein now leaves the ribosomes.

Note: Post translational modification may proceed; these include phosphorylation, summoylation, disulfide bridging, acylation, etc.

c) Explain the role of translation in a cell. (05 marks)

Translation leads to synthesis of proteins which after post-translational modification are important in;

- Nutrition, e.g. digestive enzymes, fibrous proteins in granal lamellae, casein, ovalbumin, etc
- Transport and protection; e.g. hemoglobin, myoglobin, mucin, lipoproteins (in blood)
- Body defence e.g. antibodies, fibrinogen and prothrombin
- Growth e.g. growth hormones, thyroxine
- Excretion e.g. ureases, enzymes of the urea/ ornithine cycle like arginases
- Structure, support and movement; e.g. collagen, elastin and keratin, ossein and chondrin, actin & myosin
- Sensitivity and coordination; e.g. hormones, phytochrome, rhodopsin, scotopsin, iodopsin, opsin
- Reproduction e.g. peptide hormones like FSH and LH
- Storage; zeatin (in corn seeds)/ casein (in milk)
- Receptors; hormone receptor/ neurotransmitter receptor/ receptor in chemoreceptor cell
- Movement; actin/ myosin
- Enzymes; catalase/ RuBP carboxylase
- Electron carriers; cytochromes
- Active transport; sodium-potassium pumps/ calcium pumps
- Facilitated diffusion – sodium channels and aquaporins for ADH system

QN 10 (a) State the structural features of carbohydrates that account for the existence of the wide variety of polysaccharides. (06 marks)

b) With examples, outline the chief functions of monosaccharides in living organisms. (10 marks)

c) Explain why cells of poikilothermic animals usually have a higher proportion of unsaturated fatty acids than homoeothermic animals. (04 marks)

35 (a) with suitable examples, classify enzymes based on the reactions they catalyze. (09 marks)

b) State the general characteristics of the active sites of different enzymes. (06 marks)

c) Describe the mechanism of enzyme action based on the induced fit model. (05 marks)

36(a) Explain what is meant by transcription and state its importance. (03 marks)

b) Describe the series of events that lead to formation of mRNA in a cell. (10 marks)

c) How does the molecular structure of proteins relate to its functions? (07 marks)

GENETICS

37(a) How is sex determined in humans? (04 marks)

b) A woman has four sons, one of whom is haemophiliac and the other three are normal.

(i) What are the possible genotypes of the woman and her husband? (12 marks)

(ii) Is it possible for the couple to have a haemophiliac daughter? Explain your answer. (04 marks)

38(a) Explain the meaning of the following:

(i) Genetic isolation. (02 marks)

(ii) Reproductive isolation. (02 marks)

b) Explain how the gene frequency of population may be altered. (16 marks)

QN 15 . In Drosophila, the gene for wing length and shape or the abdomen are sex linked. The gene for long wing and broad abdomen are dominant over those for vestigial wings and narrow abdomen.

a) Work out the phenotypes resulting from a cross between a vestigial winged and broad abdomen male and a homozygous long winged and narrow abdomen female fly in the;

(i) F_1 generation. (06 marks)

(ii) F_2 generation. (04 marks)

b) A cross between a female from the F_1 generation in (a)(i) with a vestigial winged and narrow abdomen make fly gave the following results;

Long winged narrow abdomen flies = 35

Long winged, broad abdomen flies = 17

Vestigial winged and narrow abdomen flies= 36

Vestigial winged, broad abdomen flies = 18

Account for the phenotypes and their relative numbers in the cross.(05 marks)

c) Explain why Drosophila are commonly used in genetic experiments. (05 marks)

EVOLUTION

QN 17 (a) Describe how abnormal hemoglobin arises in the human population

b) Explain;

(i) the effect of the gene for abnormal hemoglobin in the human population.

(ii) Why people with sickle cell trait do not suffer from malaria.

(iii) Why sickle cell mutation causes hemoglobin to clump.

QN 18(a) Describe the different forms of natural selection.

b) Explain how the following may lead to evolution of new species

(i) Increased population size.

(ii) Isolation.

QN 19 (a) Explain what is meant by;

(i) Polyploidy

(ii) artificial selection

b) Explain how polyploidy arises in sexually reproducing organisms.

QN 20 Explain the five major evidences that support the theory of evolution.

QN 21 (a) Giving examples, explain the effect of;

(i) Increased selection pressure on a population.

(ii) Stabilizing selection pressure on population.

b) Explain how comparative anatomy supports the process of evolution.

45. What is the importance of the following forms of behavior to the survival of the organisms?

a) Territorial behavior. (08 marks)

b) Courtship behavior. (12 marks)

LOCOMOTION

QN 60 (a) Compare the structure and functioning of cardiac and skeletal muscles.

b) Explain how structural features of birds are related to flight.

QN 61 (a) Discuss the reasons why animals have to move from one place to another.

To obtain food; the food requirements of most animals are unavailable in their immediate vicinity.

To capture food; e.g. carnivores running after preys
Escape from predators; essential for survival
To find mates; essential for the survival of species by allowing reproduction
Distribution of organisms; movement lo new areas allow genetic variation to be exploited and its evolutionary potential to be realized.
Reduction in competition; prevents over-crowding and intraspecific competition
To find shelter; from both biotic and abiotic factors
To maintain position; paradoxically sharks must swim to stay still (this involves movement from place to place because the shark moves horizontally to maintain a vertical position)
Reduce vulnerability to diseases; a scattered population is less likely to suffer epidemics of diseases.
Escape from waste product; these are toxic mid may carry disease.
For distribution of individuals; where individuals of different genotype move to new areas allowing realization of individual's evolutionary potential;
Prevents overcrowding; reducing intraspecific competition between organisms;
For support & maintaining position; such as in sharks that must swim continuously to maintain their position;

b) Describe how support is achieved in;

(i) Herbaceous plants.

Support in herbaceous plants is provided by the turgidity of parenchyma/ collenchyma tissues. Osmotic intake of water makes the cells turgid. The turgor pressure of the fluids in the vacuoles pushes the cell contents/ plasma membrane against the cell wall; creating support for its stem/roots and leaves. The cell walls are thickened by cellulose; which gives additional support to herbaceous plants.

(ii) Woody plants.

Support in woody plants is achieved by specialized tissues/ sclerenchyma, xylem vessels or tracheids. These tissues have cellulose cell walls which arc lignified for additional support. Sclerenchyma cells are dead; with thick cell walls that are impermeable to water. The xylem vessels have thick walls of lignin which are deposited during the plant's secondary growth. The

lignified xylem vessels form woody tissues of the stem; makes plant stronger and hence provides support. Tracheids are also dead cells with walls and very small diameters.

GROWTH AND DEVELOPMENT

.**QN 62 (a) Describe the process of primary growth in cotyledonous plants. (16 marks)**

b) How is the structure of the phloem related to function? (04 marks)

47(a) Discuss why some seeds are not able to germinate immediately they are dispersed from their parent plants when optimum conditions of germination are provided. (06 marks)

- Hard seed coat; maybe impermeable to water and oxygen or mechanically resistant; impedes emergence of plumule and radicle.
- Embryo factor; embryo may be dormant, immature/rudimentary or damaged.
- Germination inhibitors; germination may be impeded by high concentration of germination inhibitors like Abscissic acid (ABA), cyanide in apple seeds.
- Pre-mature growth of the seed and may require an after ripening period during the dry season. If not given, the seed can't germinate.
- Light insufficiency;
- Unfavorable temperature

b) Explain the importance of seed dormancy in plants. (08 marks)

- Enables the plant survive adverse conditions; only germinate under favorable environmental conditions
- Allows ample time for dispersal; and over longer distances.
- Prevents germination of all seeds at the same time which may otherwise predispose them to intense competition
- Improves species survival of seed propagated plants.
- Permits rapid reduction in the concentration of the germination inhibitors like ABA
- Allows increase in the concentration of germination promoters like gibberellins
- Reserves soluble food products;
- Permits full maturity of the embryo.
- Prevents seeds from germinating in pods

c) Explain why dormancy is more common in weeds and annual plants than in tropical trees. (06 marks)

Weeds and animals are in seasonal habitats; dormancy ensures that they do not lose all seed reserves by simultaneous germination; under temporary suitable conditions; when the

seedlings might all be wiped out; by succeeding periods of drought; so remain dormant until favorable season; conditions on the forest floor are suitable for germination throughout the year; so have little need of dormancy.

48(a) Explain how organisms have overcome the challenges of being multicellular. (12 marks)

b) Explain the relevance of animal movement from one place to another. (08 marks)

QN 63 (a) What is meant by annual rings? (02 marks)

Annual rings are distinct concentric rings of wood indicating one year's growth seen in transverse section of stems and roots of woody plants.

b) State the characteristics of secondary xylem and phloem. (10 marks)

Characteristics of secondary xylem

- Consists of tracheids, vessels, xylem fibres, xylem parenchyma cells and xylem ray cells
- The elements of secondary xylem are generally shorter than those of primary xylem
- Shows a clear distinction into axial and radial system; which is absent in primary xylem.
- Axial system has vertical rows of cells with their long axis parallel to the long axis of the plant organ.
- The radial system is made up of xylem rays,

Characteristics of secondary phloem

- Consists of sieve elements, companion cells, phloem parenchyma and phloem cells.
- Sieve tubes possess two types of sieve plates; simple or compound depending on the species
- Phloem parenchyma are elongated and have pointed ends
- Phloem fibres give mechanical rigidity to the phloem
- Translocates organic food substances to sites of utilization

c) Describe the secondary growth changes undergone by phellogen in plants. (07 marks)

Cork cambium divide, gives rise to cork; to the outside beneath the epidermis due to suberisation. The unsuberised to the outside of the phellogen forms the lenticels for gaseous exchange. The inner side of the phellogen divides mitotically to form secondary unsuberised cortex/ phelloderm. Phellogen, phellem and phelloderm form the periderm. Phloem and the periderm form the bark.

50(a) Explain the various factors affecting growth in living organisms. (14 marks)

b) Outline the roles of water as a requirement for seed germination. (06 marks)

HISTOLOGY

QN 8 (a) How are the following tissues related to functions

(i) Parenchyma tissues. (09 marks)

- Many intercellular spaces and loosely packed cells; for diffusion of gases
- Isodiametric or spherical or elongated cells; packing material; offers support/ turgidity
- Thin cellulose cell wall; permit easy diffusion of material
- Transparent cell wall; permit entry of light for photosynthesis
- Permeable walls; allows entry of water for turgidity
- Large cell vacuoles; provide storage space for materials like sugars
- Chloroplast present; traps light; allow photosynthesis
- Chloroplast present; in petals; provide color to attract insects for pollination
- Leucoplast present; store starch

(ii) Collenchyma tissues (03 marks)

Cells are polygonal in cross section; thick eel I wall due to heavy cellulose deposition; cells are elongated and parallel to the axis of die plant body; all aim at offering mechanical strength to the plant by supplementing support offered by parenchyma cells.

(iii) Sclerenchyma tissues (03 marks)

Elongated fibres and roughly spherical sclereids; heavily thickened and lignified cell wall; primary cell wall; mature cells possess empty lumens(dead cells); offer great tensile and compressional strength; augments other tissues in providing support and mechanical strength to the plain. Simple pits (aggregates of several plasmodesmata) in the non-lignified area; permit material exchange between adjacent cells.

b) State the functions of bones in animals. (05 marks)

- Bone stores and releases calcium into the blood stream at required levels
- Bone serves as a rigid structure of the body giving it shape
- Bone protects delicate organs of the body against mechanical damage
- Acts as a lever for muscles and facilitates movement within the body
- Bone contains red bone marrow responsible for synthesis of red blood cells.

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