1. An individual with **juvenile diabetes** was injected with insulin or allowed to inhale insulin (a recent product administered using a nasal spray).
Figure .1.1 shows the concentration of insulin in the blood plasma in the 480minutes after injecting or inhaling insulin. In both cases insulin was of the same type obtained from a genetically engineered *Escherichia coli.*
Figure .1.2 shows the concentration of glucose in the blood plasma in the 480minutes after injecting or inhaling insulin.
Study both graphs and use them to answer the questions that follow.

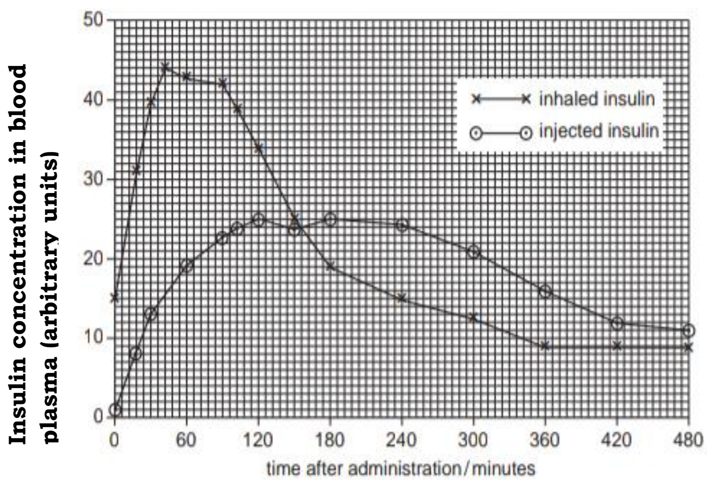


Fig 1.1

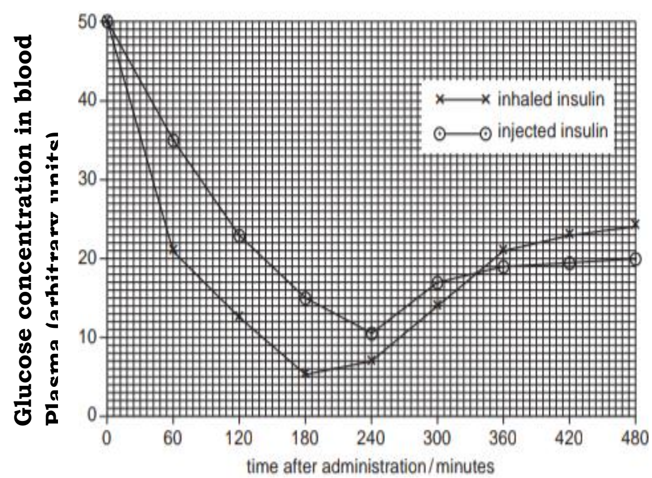


Fig 1.2

(a) What are causes and symptoms of juvenile diabetes?
(b) Compare the levels of injected insulin and inhaled insulin in the blood plasma.
(c) Explain the effect of injected insulin on the blood glucose concentration
(d) Suggest the advantages and disadvantages of inhaling insulin rather than injecting insulin.
(e) Explain the need for regulation of blood glucose concentration

Possible solutions

(a) Majorly caused by autoimmune destruction of $\beta-$ cells of the islets of Langerhans in the pancreas; thus insufficient quantities of insulin are secreted;
Also caused by Viral infection; and genetic factors;
Its characterized by increased thirst; frequent urination; fatigue; blurred vision; unintended weight loss; bed wetting in children who previously could not wet the bed;

(b) Similarities
In both injected and inhaled insulin,
- **Peak is attained**
- **Blood plasma concentration increases first, then decreases;**
- **Blood plasma concentration remains constant from 420minutes to 480minutes;**

Differences

Inhaled blood insulin concentration	Injected blood insulin concentration
Higher peak attained	**Lower peak attained**
Peaks earlier	**Peaks later**
Higher from 0minutes to 156minutes	**Lower from 0minutes to 36minutes**
Lower from 156minutes to 480minutes	**Higher from 156minutes to 480minutes**

Increases rapidly to a peak from 0minutes to 42minutes	**Increases gradually from 0minutes to 42minutes**
Decreases gradually from 42minutes to 90minutes	**Increases gradually from 42minutes to 90minutes**
Decreases rapidly first the gradually from 90minutes to 240 minutes	**Remains almost constant from 90minutes to 240minutes**

(c) From 0minutes to 240minutes, increase in injected blood insulin concentration, rapidly decreases blood glucose concentration to a minimum; because transportation of injected insulin to the liver; stimulates liver cells to increase rate of glucose oxidation to release energy; convert excess glucose to glycogen and fats; stored in the liver, muscle and adipose tissue beneath the skin respectively; subsequently lowering the blood glucose concentration;
From 240minutes to 420minutes, decrease in injected blood insulin concentration, gradually increases blood glucose concentration because it lowers the uptake of glucose by cells;

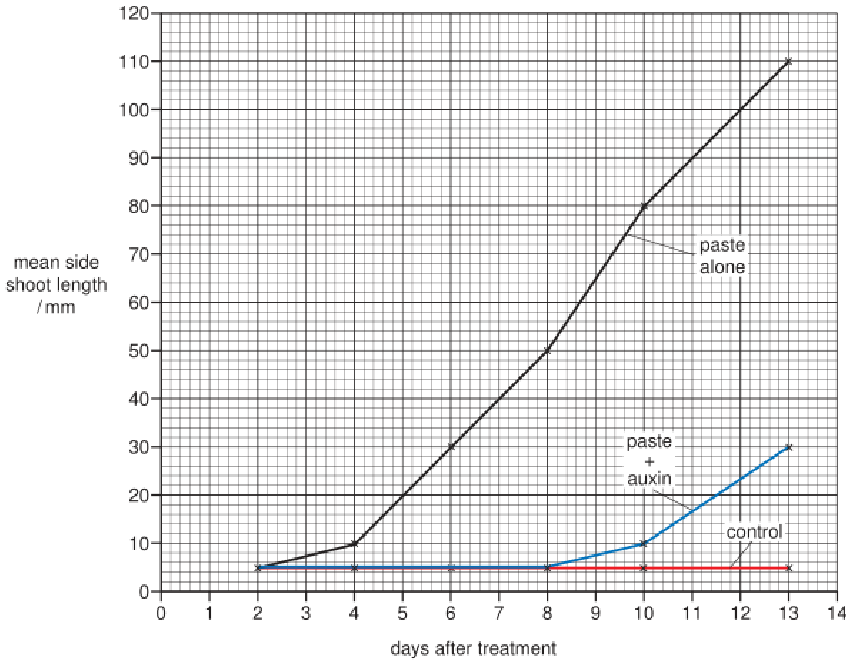
(d) <u>Advantages</u>
- **faster response time**
- **less chance of infection/contamination**
- **applicable for people with needle phobia**

<u>disadvantages</u>
- **could cause larger swings in blood glucose concentration**
- **not long lasting; thus need to be taken frequently**
- **possible variability of the dose**

(e) Glucose is a respiratory substrate for cells e.g. brain cells; thus decrease in blood glucose concentration below norm deprives the cells of energy; resulting into fainting/ketosis;
Excess of glucose in blood above norm; increases the osmotic pressure of blood beyond that of the surrounding cells; drawing water from the cells into blood; dehydrating the cells of the body; enzymatic activities are hindered; impairing cellular metabolism;

2. (a) What is meant by the term apical dominance.
(b) An investigation was carried out into the effects of a plant growth regulator, auxin(IAA) on apical dominance.
- The apical buds of 20 pea plants were cut off and discarded
- The cut surfaces of 10pea plants were coated with inert paste containing auxin
- The cut surfaces of the other group of 10pea plants were coated with inert paste alone.
- A further group of 10 pea plants did not have their apical buds removed and were not coated with paste.

The lengths of the side shoots of plants in each of the three groups were measured at regular time intervals and mean values calculated. The results are shown in the figure below.



(i) Explain why side shoots increase length when the terminal buds are removed.
(ii). Calculate the percentage difference at 13days in the mean length of side shoots of plants treated with paste alone compared with the plants treated with paste and auxin.
(iii) Compare the variation in the mean length of side shoots of plants treated with paste alone and plants treated with paste and auxin.
(iv) Explain the variation in the mean length of side shoots with paste + auxin.
(v) How can the phenomenon demonstrated above be used in agriculture?

Possible solutions

(a) Is a phenomenon in which auxins from the apical/terminal bud, transported down the shoot directly inhibits growth of lateral buds, causing increase in the length of shoot at the expense of lateral branching.

(b) (i) Auxins inhibit growth of side shoots; thus removal of the terminal buds; inhibits synthesis of auxins; thus concentration of auxins decreases; allowing cell division and thus elongation of side shoots;

(ii)

$$\frac{(\textit{mean length of side shoots of plants treated with paste alone} - \textit{mean length of shoot of plants treated with paste} + \textit{auxin}}{\textit{mean length of shoots of plants treated with paste} + \textit{auxin}} \times 100$$

% difference in length = $\frac{110-30}{30}$ **X 100 = 266.7%**

(iii) <u>similarities</u>

In both side shoots of plants treated with paste alone and plants treated with paste and auxin.

- **Mean length increases from 8days to 13days of treatment;**
- **Highest mean side shoot length is attained**

<u>Differences</u>

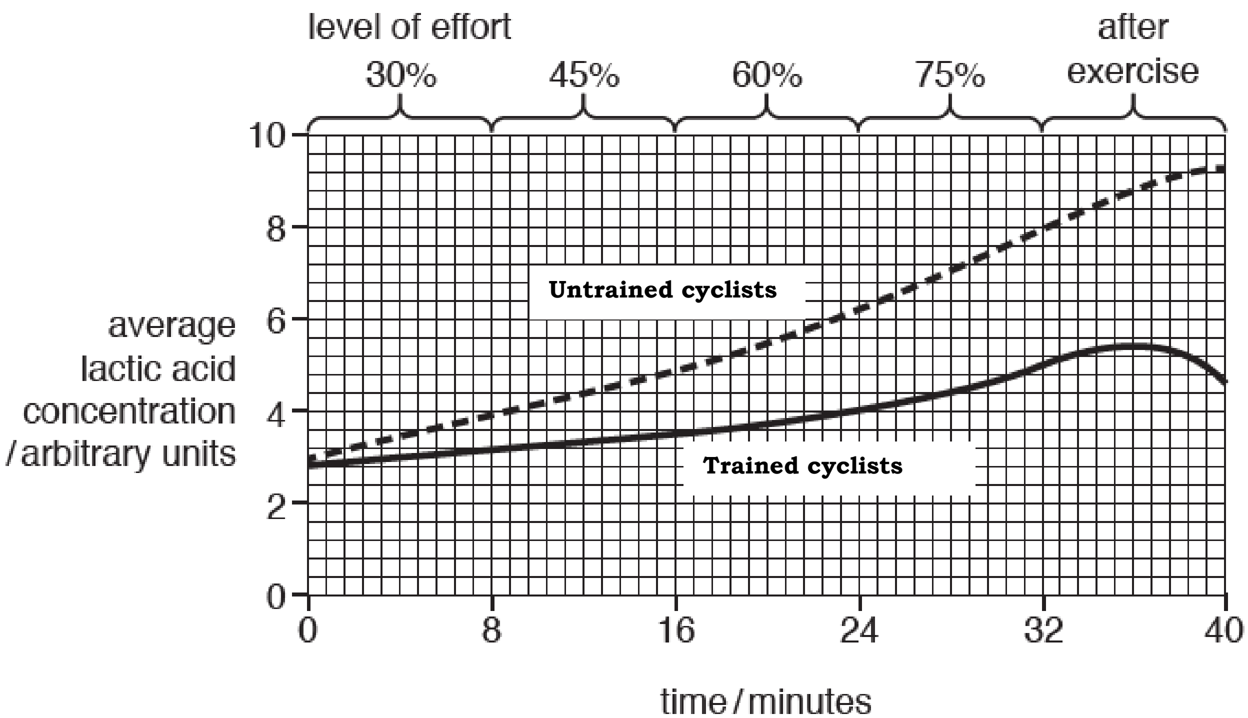
Mean length of side shoots of plants treated with paste alone	Mean length of side shoots of plants treated with paste +auxin
Higher from 2days to 13days of treatment	**lower from 2days to 13days of treatment**
Increases gradually first , then rapidly from 2days to 8days of treatment	**Remains constant from 2days to 8days of treatment**

(iv) **From 2days and 8days of treatment, mean length of side shoots remains constant/no increase in length occurs because auxins diffused from paste into plant shoots; inhibiting elongation of side shoots;**

From 8days to 13days of treatment, mean length of side shoots increases; because little auxin is left; thus cell division and thus elongation of side shoots occur;

(v)Made use of in pruning fruit trees, tea and coffee bushes; where the young shoots are cut off at about one half of their length, resulting into bushy, rather tall plants;

3. In an investigation on the effect of increasing level of exercise, a group of trained and untrained cyclists were each allowed to cycle at four levels of effort; 30%, 45%, 60% and 75% of their maximum speed. They cycled for eight minutes at each level of effort. Figure below shows an average production of lactic acid in the blood of the trained and untrained cyclists in this investigation.



(a) Predict and explain what would happen to the pulse rate of all the cyclists during the exercise.

(b) Describe the changes in the average lactic acid concentration in the blood of the untrained cyclists during and after the period of exercise.

(c) Explain why the lactic acid concentration in the blood in trained cyclists differ from the untrained cyclists eight minutes after the exercise.

(d) Describe the process leading to production of lactic acid during cycling by the two groups of cyclists.

(e) What is the fate of the lactic acid produced during cycling by the two groups of cyclists?

Possible solutions

(a) Pulse rate increases; because cycling is an energy demanding activity; requiring rapid supply of high amounts of oxygen; and glucose; to the respiring tissue (skeletal muscle) thus heart beats faster; to rapidly pump blood via dilated arterioles leading to skeletal muscles; to supply glucose and oxygen for aerobic respiration generating energy for muscle contraction;

Increased metabolism also accumulates carbon dioxide in blood; which need to be removed from blood; also increasing pulse rate.

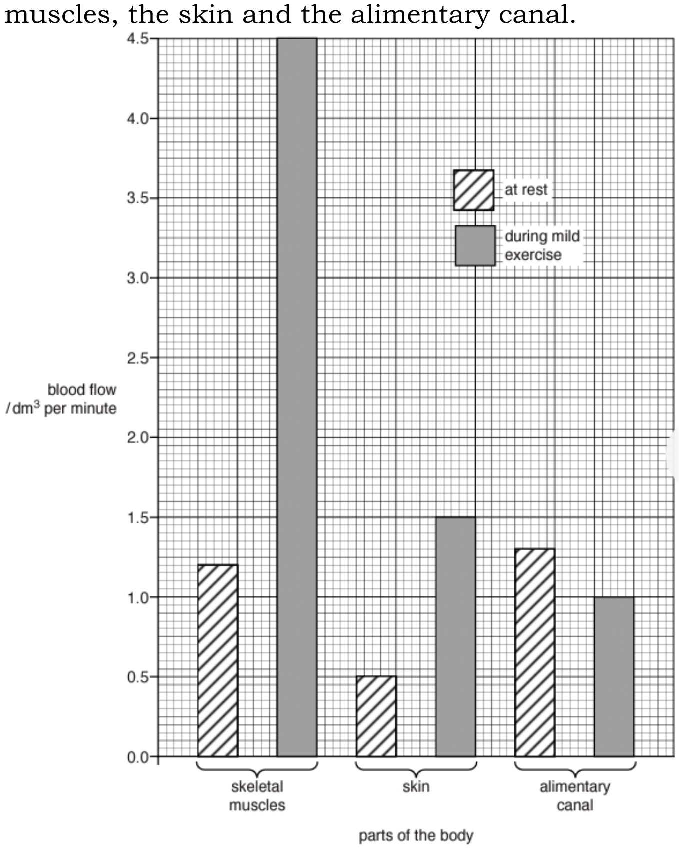
(b) During exercise from 0minutes to 32minutes, average lactic acid concentration increases first gradually then rapidly;
After exercise, from 32minutes to 38.4minutes, average lactic acid concentration increases continues to increase rapidly; to a maximum;
After exercise, from 38.4minutes to 40minutes, average lactic acid concentration remains constant;

(c) Less anaerobic respiration than aerobic respiration occurs in trained cyclists compared to untrained cyclists; producing less lactic acid during the exercise; as more oxygen is supplied to respiring skeletal muscle tissue; thus requiring less amount of oxygen to oxidize the lactic acid to water; and carbon dioxide; after exercise; allowing faster breakdown of lactic acid;

(d) Pyruvate/pyruvic acid from glycolysis; accepts hydrogen atoms; from reduced NAD; catalyzed by lactate dehydrogenase enzyme; forming lactic acid; no energy is released or used up;

(e) Lactic acid from anaerobiosis, is transported to liver; and in presence of oxygen; its converted to pyruvate; oxidized to carbon dioxide and water; releasing energy;
In the liver it can also be converted to glycogen; and stored;

4. An investigation was carried out into the blood flow in different parts of the body when resting and during a mild exercise. Figure below shows results for the skeletal muscles, the skin and the alimentary canal.



(a). Calculate the percentage change in blood flow to the
   (i) alimentary canal
   (ii) skin
   (iii) skeletal muscles during exercise.

(b) Account for observed trends in the blood flow to the body parts shown in the figure.

(c) Explain the following observations
   (i) blood flow to the brain stay the same during rest and exercise
   (ii) blood flow to the heart muscle increases when the person exercises.

(d) How is blood flow in the veins controlled?

Possible solutions

(a) (i) $\frac{1.0-1.3}{1.3}$ **X 100; = -23.08%**

(ii) $\frac{(1.5-0.5)}{0.5}$ **X 100; = +200%**

(iii) $\frac{(4.5-1.2)}{1.2}$ X100; **+275%**

(b) Blood flow to the alimentary decreases during exercise because digestion/absorption as large quantities of blood need to directed to the active skeletal muscles;

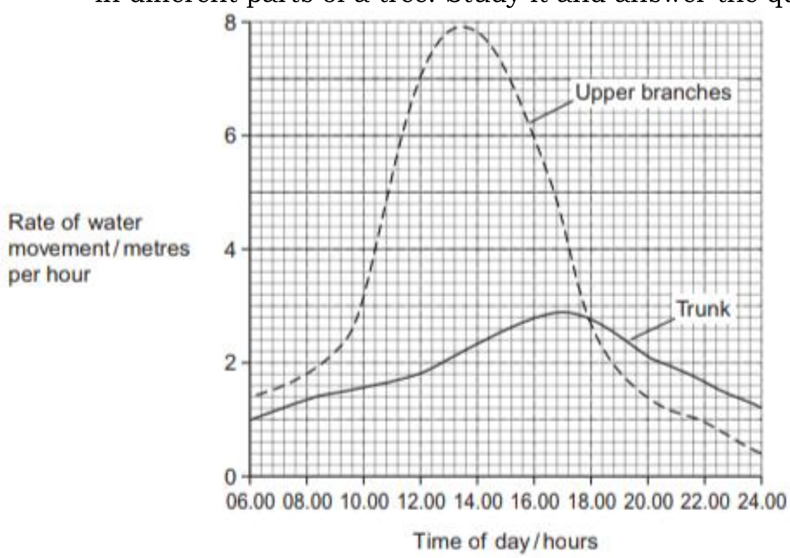
Blood flow to skeletal muscles increases during exercise because large amounts of nutrients and oxygen; need to rapidly supplied to the active skeletal muscles; to generate energy during respiration for muscle contraction;
Blood flow to the skin increases because vessels leading to the skin dilate; caused by increased body temperature generated by increased metabolism; thus need to lose heat through the skin by radiation and convection;

(c) (i) Brain(cell) function has to be constant/cells cannot reduce their energy requirements; should the supply decrease, there would a disturbance of the brain function; leading to a break down in the complex integration and control of body systems;
(ii) Need to supply more glucose and oxygen; to the muscle to provide energy facilitating the strong/powerful and frequent contractions of the heart muscle to pump blood to the active skeletal muscles;

(d) Skeletal muscles of the limbs contract; squeezing the thin walled veins; forcing blood through them to the heart under high pressure;
Large diameter of the veins; minimizes resistance to blood flow;
Semi lunar valves along their length; prevent back flow of blood ensuring a unidirectional flow of blood;
Inspiratory movements during breathing in reduces the thoracic pressure; draining blood towards the heart;
Gravity allow return of blood from some regions above the heart;
Residual pressure of the heart, usually 100mmHg or less, pulls blood from the veins into the heart;

5. (a) Describe the cause of root pressure, and clearly state its role in the ascent of water up a plant.

(b) A graph in the figure below shows the rate of water movement over a 24-hour period in different parts of a tree. Study it and answer the questions that follow.



(i) Describe the changes in the rate of water flow in the upper branches.
(ii) Compare the changes in the rate of water flow in the upper branches and the trunk
(iii) Explain how the results of the investigation support the cohesion-tension theory.
(c) How are plant tissues for water movement adapted to this function?

Possible solutions

(a) Caused by active secretion of salts into the xylem tissue by endodermal cells; lowering water potential of xylem below that of endodermal cells; water is drawn from the neighboring endodermal cells by osmosis into the xylem; generating a positive hydrostatic pressure/root pressure; only strong enough to force water from the root to the xylem of stems of relative short plants; and slowly transpiring herbaceous plants;

(b) (i) From 06.20hrs to 09.60hrs rate of water movement increases gradually;
From 09.60hrs to 13.60hrs rate of water movement increases rapidly to a peak;
From 13.60hrs to 18.08hrs rate of water movement decreases rapidly;

From 18.08hrs to 24hours rate of water movement decreases gradually;

(ii) <u>Similarities</u>

In both upper branches and trunk, rate of water movement,

- **Attains a peak;**
- **Increases and then decreases;**
- **Decreases gradually from 1800hrs to 2400hrs**
- **Are equal at 1800hrs**

<u>Differences</u>

<u>Rate of water movement in upper branches</u>	<u>Rate of water movement in Trunk</u>
higher peak attained	**Lower peak attained**
<u>Peak attained earlier</u>	**<u>Peak attained later</u>**
<u>Higher from 0600hrs to 1800hrs</u>	**<u>Lower from 0600hrs to 1800hrs</u>**
Lower from 1800hrs to 2400hrs	**higher from 1800hrs to 2400hrs**
Increases rapidly from_09.60hrs to 13.60hrs	**Increases gradually from 09.60hrs to 13.60hrs**
Decreases rapidly from 13.60hrs to 1800hrs	**Increases gradually from 13.60hrs to 1800hrs**

(iii) Rate of water movement peaks earlier in the upper branches because by continuous loss of water through evaporation by the spongy mesophyll cells of leaves in the upper branches into the air spaces; creating a suction force that continuously pulls up water; subsequently increasing rate of water movement in the trunk;

(c) End walls of the vessels are broken down; to give uninterrupted flow of water from roots to the leaves;

Tracheids have tapering endwalls containing cellulose lined with pits that allows water to pass from cell to cell;

Side walls of xylem vessels and tracheids are perforated to allow lateral movement of water;

Cell walls of the xylem vessels are impregnated with lignin to increase adhesive forces for upward movement of water;

Lignified cells have great tensile strength preventing vessels from buckling when conducting water under tension;

Xylem vessels and tracheids are placed end to end forming a continuous column to allow transportation of water over long distances;

Xylem vessels are hollow allowing free movement of water;

Long and narrow; to increase capillary forces;

6. The table below shows the mean rate of abdominal pumping of an insect before and during flight.

Stage of flight	**Mean rate of abdominal pumping (dm^3 of air kg^{-1} hr^{-1})**
Before	42
During	186

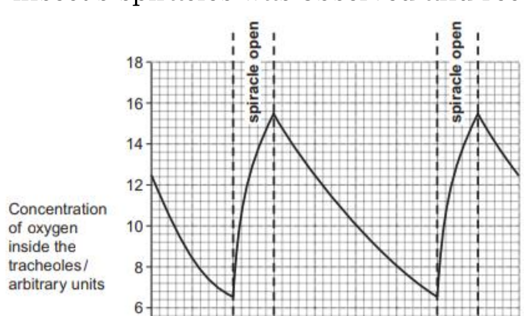
(a) (i) What is meant by 'abdominal pumping?'

(ii) Calculate the percentage increase in the rate of abdominal pumping before and during flight.

(iii) Account for the difference in the mean rate of abdominal pumping before and during flight.

(iv) Explain the absence of abdominal pumping in many small insects.

(b) The figure below shows results of an experiment to measure the levels of respiratory surface of an insect over a period of time. During the experiment, the opening of the insect's spiracles was observed and recorded.



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(i). Calculate the frequency of spiracle opening

(ii) Explain the effect of spiracle opening on the oxygen concentration in the tracheoles.

(iii) Explain the difference in the frequency of spiracle opening in aquatic and terrestrial insect.

(iv) Explain how oxygen delivery to tissues of insects controlled during exercise.

Possible solutions

(a) (i) Is the contraction of muscles associated with

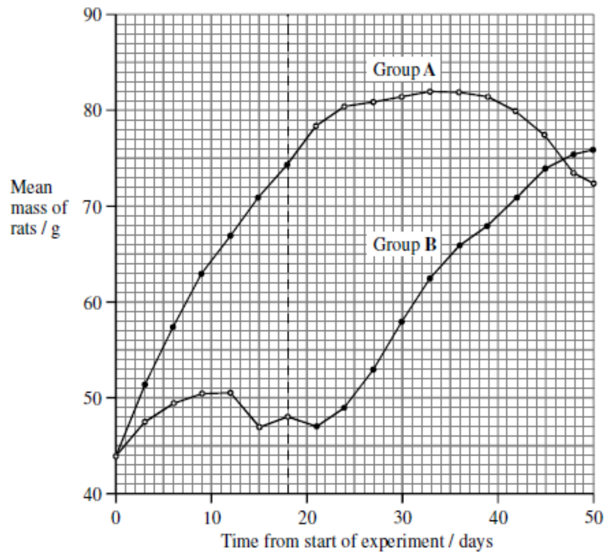
(iii) Mean rate of abdominal pumping increases during flight because flight is a highly energy demanding activity; thus more oxygen rapidly diffuses into the muscle tissue from the tracheoles; used during aerobic respiration; maintaining a greater concentration gradient;
With high metabolism during flight, accumulation of carbon dioxide in the muscle tissue occurs; thus need to be removed from the body;
(iv) Small insects have a large surface area to volume ratio; allowing efficient diffusion of respiratory gases;
Thin body surface provides a short diffusion distance thus rapid diffusion of respiratory gases occur;
(b) (i) 6; /8;
(ii) From 4minutes to 6minutes, and 14minutes to 16minutes, opening of spiracles rapidly increases oxygen concentration in the tracheoles because relaxation of abdominal muscles which increases abdominal volume while abdominal pressure decreases below atmospheric pressure;
(iii) Spiracle opening is less frequent in terrestrial insect than aquatic insect because there is need to minimize excessive water loss by evaporation via opened spiracle in terrestrial insect;
(iv) During exercise, metabolic activity of the muscles increases; muscles respire anaerobically; lactic acid accumulates; lowering the water potential of the muscle cells below that of the tracheoles; water moves from the tracheoles into the muscle cells by osmosis; more space is created for air/oxygen; more oxygen diffuses into the tracheoles for delivery to the body tissues;

7. Hopkins carried out an experiment out to investigate the effect on growth of rats on including milk in their diet. Two groups, **A** and **B**, each consisting of eight young rats fed on a synthetic diet (mice pellets) of purified casein, sucrose, inorganic salts and water.
Group **A** received a supplement of 30cm^3 of milk per day for the first 18days then received no further milk.
Group **B** was given no milk for the first 18days, then received a supplement of 3cm^3 of milk per day.

(a) From the graph, calculate the average growth rate of rats from the two groups **A** and **B** at;
(i).0-10th day for group **A**.
(ii)..20th- 50th day for group **B**

(b) (i). Compare the changes in the mean mass of both groups of rats during the whole experiment.
(ii). Explain the changes in the mean mass of both groups of rats in c(i) above

(d).Describe,
(i).the **physiological significance** of including mineral salt like calcium in the diet of rats?
(ii) how the rats were able to deal with excess proteins in their diet



(a) (i) **Average growth rate=** $\frac{\text{change in mean mass}}{\text{change in time}}$;

$=\frac{(67-45)}{(10-0)}$; $\frac{22}{10}$;

=**2.2 g/day**;

(ii) **Average growth rate** $=\frac{(76-48)}{(50-20)}$; $\frac{28}{30}$; = **0.93g/day;**

(b)(i) **Similarities**

-When no milk is given, mean mass of both group of rats increases; and decreases;
-Both groups of rats have the same mean mass at day 0; and day 46;
--When milk is added, mean mass of both groups of rats increases;
-From 0 to 9th day; and 20th day to 35.5th day; mean mass of both groups of rats increases;
-From 15th day to 18th day; mean mass of both groups of rats increases gradually;

Differences;

Group A rats	Group B rats
From 46th day to 50th day, mean mass is lower	From 46th day to 50th day, mean mass is higher
From 0 to 9th day, mean mass increases rapidly	From 0 to 9th day, mean mass increases gradually
From 9th day to 11th day , mean mass increases rapidly	From 9th day to 11th day, mean mass remains constant
From 11th day to 15th day, and 18th to 20th day, mean mass increases rapidly	From 11th day to 15th day, and 18th day to 20th day, mean mass decreases gradually
From 35.5th day to 40.5th day, mean mass decreased rapidly.	From 35.5th day to 40.5th day, mean mass increased rapidly.
Attains a maximum mean mass on day 36/earlier	Attains a maximum mean mass on day 50/later;
From 40.5th day to 50th day, mean mass decreased gradually.	From 40.5th day to 50th day, mean mass increased gradually.
From 0 to 46th day, mean mass is higher	From 0 to 46th day, mean mass is lower
Grows faster when milk is added	Grows slower when milk is added

(ii). **Mean mass of both groups of rats increases rapidly when they received milk because milk contains lactose sugar; oxidized to provide energy; required for growth; milk provides extra proteins; for growth; extra calcium; for bone and teeth formation; Milk also contains vitamins for proper growth;**

Mean mass of both groups of rats decreased gradually when milk was stopped because the lactose, vitamins and extra proteins needed for growth of different tissue were lacking;

(d). (i) **Calcium ions activate the troponin protein; thereby allowing it displace tropomyosin; from the myosin bridge binding site on the thin actin filament; myosin bridge thus attaches to the thin actin filament; forming actomyosin; during muscle contraction.**

Concentration of calcium ions when sufficiently high; activates ATP synthetase enzyme; that catalyse ATP hydrolysis; providing energy for muscle contraction;

Calcium ions together with thromboplastin and vitamin K, convert the inactive prothrombin to thrombin; during blood clotting;

Formation of strong bones and teeth;

Calcium ions stimulate the release of neurotransmitter substances; by synaptic vesicles into the synaptic cleft; during impulse transmission along a synapse

(ii). **Excess proteins are deaminated in the liver; forming urea; excreted in urine;**

8. The table below shows mean rate of carbon dioxide production during the dark in three parts of an ecosystem. Study it and answer the questions that follow.

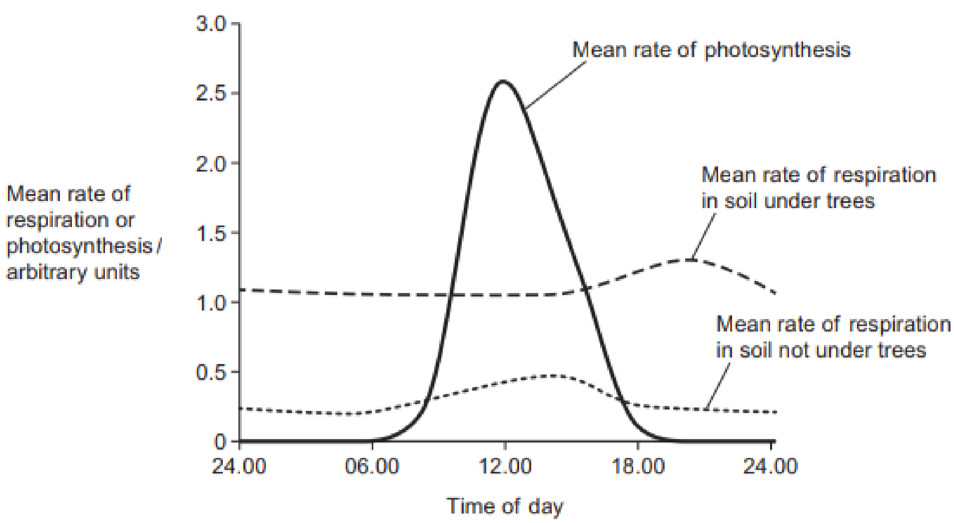
	Part of ecosystem		
	Leaves of plants	Stems and roots of plants	Non- photosynthetic soil organisms
Mean rate of carbon dioxide production($cm^3\ m^{-2}\ s^{-1}$)	0.032	0.051	0.045

(a) (i) What measurements would have been made in order to calculate the rate of carbon dioxide production?

(ii) Explain why measurements of carbon dioxide release in the dark were used to calculate the mean rate of carbon dioxide production of the leaves.

(iii) Using the information provided in the Table, suggest why plants may not carry out more respiration than non-photosynthetic organisms in the ecosystem.

(b) Graph in figure below shows the mean rate of respiration in soil under trees and soil not under trees in the same wood. It also shows the mean rate of photosynthesis in the trees. *Measurements were taken at different times of the day during the summer.*



(i) Compare the changes in the mean rate of respiration in soil under trees and mean rate of respiration in soils not under trees.

(ii) Suggest an explanation for the difference in the mean rate of respiration in soil under trees and mean rate of respiration in soils not under trees between 06.00 and 12.00.

(iii) Explain the following observations

- Increase in the mean rate of photosynthesis increases the mean rate of respiration in soil under trees

- There is a delay between increase in the mean rate of photosynthesis increases the mean rate of respiration in soil under trees

Possible solutions

(a) (i) volume of carbon dioxide given off; in a known area within a set time;

(ii) In the dark, no photosynthesis occurs; which use up the released carbon dioxide;

(iii) The results in the table only includes heterotrophic organisms; and does not include animals above the ground or other soil organisms;

The results also do not account for anaerobic respiration;

(b) (i) similarities

In both mean rate of respiration in soil under trees and mean rate of respiration in soils not under trees,

- **Peak is attained;**
- **Remains constant from 24.00 to 06.00;**

Differences

mean rate of respiration in soil under trees	mean rate of respiration in soil not under trees
Always higher	**Always lower**
Higher peak attained	**Lower peak attained**
Peak attained later	**Peak attained earlier**
Remains constant from 06.00hrs to 15.00hrs	**Increases gradually from 06.00hrs to 15.00hrs**
Increases gradually from 15.00hrs to 21.00hrs	**Remains constant from 15.00hrs to 21.00hrs**

(ii) Mean rate of respiration in soil under trees is higher than in soil not under trees; because there are more roots under tree; that carry out lots of respiration; / more respiratory substrate under trees; thus more organisms carry out respiration;

Mean rate of respiration in soils not under trees increases while that in soil under trees remains constant; because soil not under trees are exposed to direct sunlight; gets warmer; providing a more suitable temperature; for efficient functioning of respiratory enzymes; rate of respiration is thus increased;

(iii) -Photosynthesis produces sugars; transported to roots; used for respiration;

-Time is taken for manufactured sugars during photosynthesis to be transported to the roots;

9. In an experiment to investigate the effect of chilling (exposure to low temperatures) on the mass of phosphate in seeds, cherry seeds were exposed to different temperatures and mean mass of the phosphate in their embryos measured over a period of 16weeks. The graph in figure below shows results. Study it and answer the questions that follow.

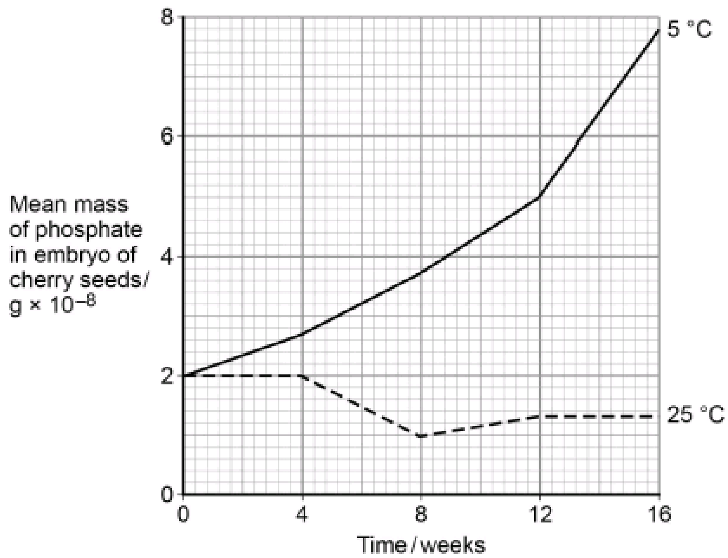
(a) Compare the changes in the mean mass of phosphate in the embryo of cherry seeds at the two temperatures.

(b) Account for difference in mean mass of phosphate in the embryo of cherry seeds at the two temperatures.

(c)Explain how chilling requirements of certain plant species is important in countries with seasonal changes in environmental conditions.

(d) Apart from chilling, describe other methods of breaking named causes of dormancy in seeds.

(e) Explain the importance of dormancy to seeds.



Possible solutions

(a) <u>Similarities</u>

At both 5℃ and 25℃, mean mass of phosphate in the embryo of cherry seeds increases from 8weeks to 12weeks;

<u>Differences</u>

Mean mass of phosphate at 5℃	Mean mass of phosphate at 25℃
Higher from 0 weeks to 16weeks	**lower from 0 weeks to 16weeks**
Increases from 0weeks to 4weeks; and from 12weeks to 16weeks	**Remains constant from 0weeks to 4weeks; and from 12weeks to 16weeks**
Increases gradually from 4weeks to 8weeks	**Decreases from 4weeks to 8weeks**
Increases rapidly from 8weeks to 12weeks	**Increases gradually from 12weeks to 16weeks**

(b) From 0weeks to 16weeks, mean mass of phosphate at 5℃ is higher than at 25℃; because lower temperature, allows phospholipid molecule in cherry seeds to be broken down into phosphates; transported to the embryo;

(c) Since chilling avails the phosphate utilized for growth of embryo of cherry seeds into plants; seeds of certain plant species in countries with seasonal changes in environmental conditions, remain dormant in unfavourable environmental conditions; preventing them from losing all food reserves by simultaneous germination under temporary suitable conditions when the seedling will be wiped out by succeeding period of unfavourable conditions;

(d)

Cause of dormancy	Ways of breaking
Hard and impermeable testa	**-microbial breakdown in the soil e.g. by fungi -digestive action by enzymes of mammals, birds -exposure to alternating low and high temperatures; allowing expansion and contraction that cracks the testa -treatment with Sulphuric acid and alcohol that removes a waxy layer of seed coat; facilitating water uptake by imbibition; Physical abrasion of seeds by sand paper**
Immature embryo	**Allowing an after ripening period;**

Germination inhibitors	**Treatment of seeds with germination stimulators e.g. Gibberellic acid**

(e) Allows seeds to survive adverse conditions e.g. drought
Allows time for dispersal and thus colonization of new habitats
Allows the embryo to grow to full maturity
Ensures longevity of seeds
To remove germination inhibitors

10. During an action potential, the permeability of the cell-surface membrane of an axon changes. The graph in fig 10.1 below shows changes in permeability of the membrane to sodium ions (Na^+) and to potassium ions (K^+) during a single action potential.

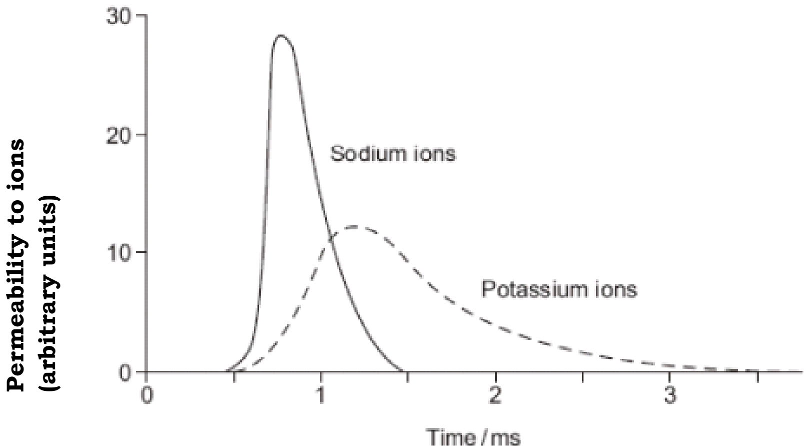
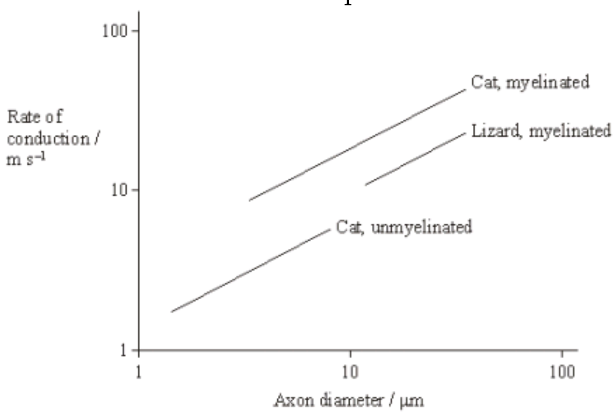


Fig 10.1

(a). (i) What is an action potential?
(ii) Explain the shape of the curve for sodium ions between 0.5ms and 0.7ms
(iii) During an action potential, the membrane potential rises to +40Mv and then falls. Using information from the graph, explain the fall in the membrane potential.
(iv) Explain how the resting potential is re-established during exercise.

(b) A graph in figure 10.2 shows the relationship between axon diameter, myelination, and rate of conduction of the nerve impulse in a cat and a lizard.



(i) Explain the effect of myelination and axon diameter on the rate of nerve impulse conduction
(ii) Account for difference in rate of conduction of nerve impulse in myelinated neurons in cats and lizards for the same diameter of axon
(iii) The cat was diagonized of multiple sclerosis. Suggest and explain how this may affect the transmission of nerve impulse.

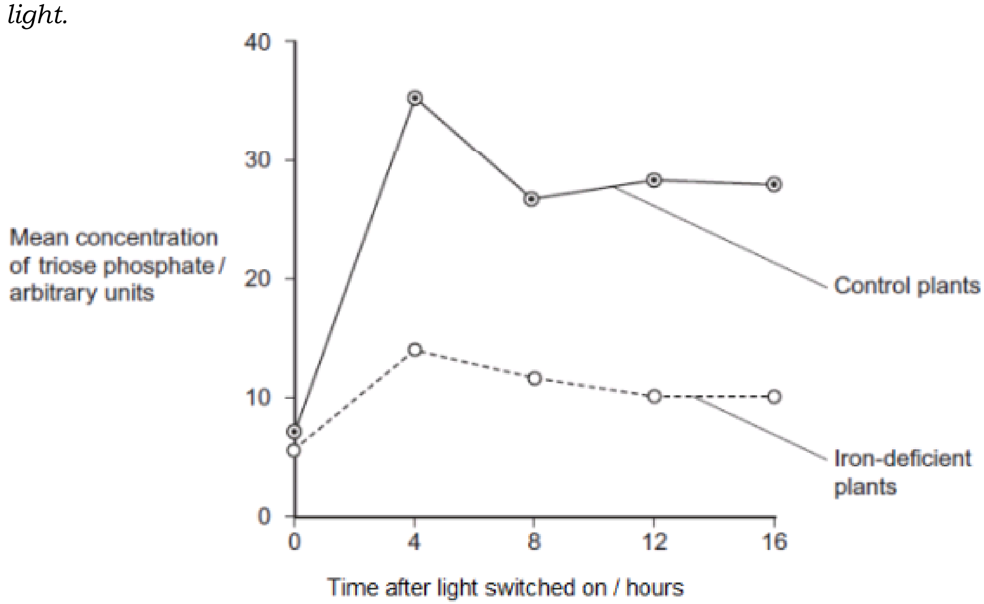
F

lus;
s increases rapidly to a peak;
sodium ion gates open rapidly;
sodium ions diffue into the membrane; making inside of the axon less negative/more positive/depolarisation occurs; subsequently causing more and more sodium ion gates to open; allowing more inward diffusion of sodium ions;
(iii) Potassium ion gates open; sodium ion gates close; potassium ions diffuse out of the axon;
(iv) sodium ions are actively transported/ pumped out of the axon; while potassium ions are pumped in;

(b) (i)Myelination increases rate of conduction of impulses; becauses impulses leap from one node to another;
Increase in axon diameter increases rate of conduction of impulses; because of less resistance by axon plasm;

(ii) rate of conduction in myelinated neurons of cats is faster than in lizards; because cats are endotherms, capable of maintaining higher body temperature; thus faster rate of diffusion of ions/faster opening of ion pores/gates/channels;
(iii) myelin sheath is destroyed; thus decrease in rate of impulse conduction; as no saltatory conduction occurs;

11. In an experiment to investigate the effect of iron deficiency on the production of triose phosphate in sugar beet plants, scientists grew the plants under the same conditions with their roots in a liquid growth medium containing all the necessary nutrients. Ten days before the experiment, half the plants were transferred to a liquid growth medium containing no iron.
Figure below shows the concentration of triose phosphate produced in these plants and in some control plants; *at the end of 6hours in the dark, and then for 16hours in the light.*



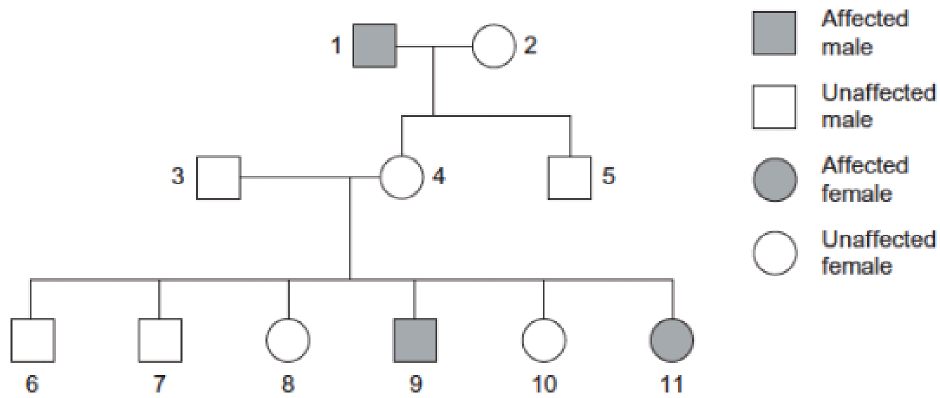
(a) Explain why
  (i) the experiment was carried out at a high carbon dioxide concentration
  (ii) it was important to grow the plants under the same condition up to ten days before the experiment
  (iii) the plants were left in the dark for 6hours before the experiment
(b) Account for the change in the mean concentration of triose phosphate in the ion deficient plants between 4hours to 16hurs.
(c) Explain the effect of iron deficiency on the uptake of carbon dioxide.

Possible solutions

(a) (i) So that carbon dioxide concentration is not a limiting factor; of photosynthesis;
(ii) Iron is the variable;
(iii) To ensure equal amounts of triose phosphate at the start;
(b) Mean concentration of triose phosphate decreases; because iron deficiency less ATP; and reduced NADP is produced; during light dependent stage; thus less glycerate-3-phosphate produced; subsequently decreasing amount Triose phosphate formed;
(c) With less triose phosphate produced; less RUBP; a carbon dioxide acceptor is formed; thus decreasing carbon dioxide fixation;

12. Tay-Sachs disease is a human inherited disorder. Sufferers of this disease often die during child hood. The allele for Tay-Sachs disease t, is recessive to allele T, present in

unaffected individuals. The diagram shows the inheritance of Tay-Sachs in one family.



(a). Explain one piece of evidence from the diagram which proves that the allele for Tay-Sachs is
(i) recessive
(ii) not carried on the X chromosome
(b) (i) In human population, one in every 1000 children born had Tay-Sachs disease. Use Hardy-Weinberg equation to calculate the percentage of this population you would expect to heterozygous for this gene. Show your working.
(ii) The actual percentage of heterozygotes is likely to be lower in future generations than the answer obtained in b (i) above. Explain why.
(c) Explain why it is possible to eliminate all dominant alleles of a particular gene from a population

Possible solutions

(a) (i) Unaffected parents, 3 and 4 have affected children (9, and 11); implying both 3 and 4 are carriers/heterozygotes;
(ii) Unaffected father, 3 produce affected daughter, 11; / parents 3 and 4 would only produce unaffected females;

(b) (i) let **p** represents frequency of dominant allele
q represents frequency of recessive allele
$\mathbf{p^2}$ represent frequency of the dominant genotype
$\mathbf{q^2}$ represent frequency of the Homozygous recessive genotype
2pq represent frequency of heterozygotes
$\mathbf{q^2}$ represent the frequency of cystic fibrosis individuals;

$\Rightarrow q^2 = \frac{1}{1000} = 0.001;$

$q = \sqrt{0.001} = \mathbf{0.0316}$;

From $\mathbf{p + q = 1}$

$\mathbf{p} = 1 - 0.0316 = \mathbf{0.9684}$

Heterozygotes

$2pq = 2\times0.0316\times0.9684 = 0.0612$; **61.2%**

(ii) Affected individuals usually die before reproductive age; thus do not pass on the allele to the succeeding generation;

(c) Dominant alleles are always expressed in the phenotype; once they appear in a genotype; which exposes them to forces of natural selection/changing environmental demands; If the dominant gene is harmful/lethal all the individuals possessing it will be selected against;/will be at selective disadvantage and eliminated by natural selection hence eliminating all the dominant alleles;

END