GCE O'LEVEL BIOLOGY NOTES

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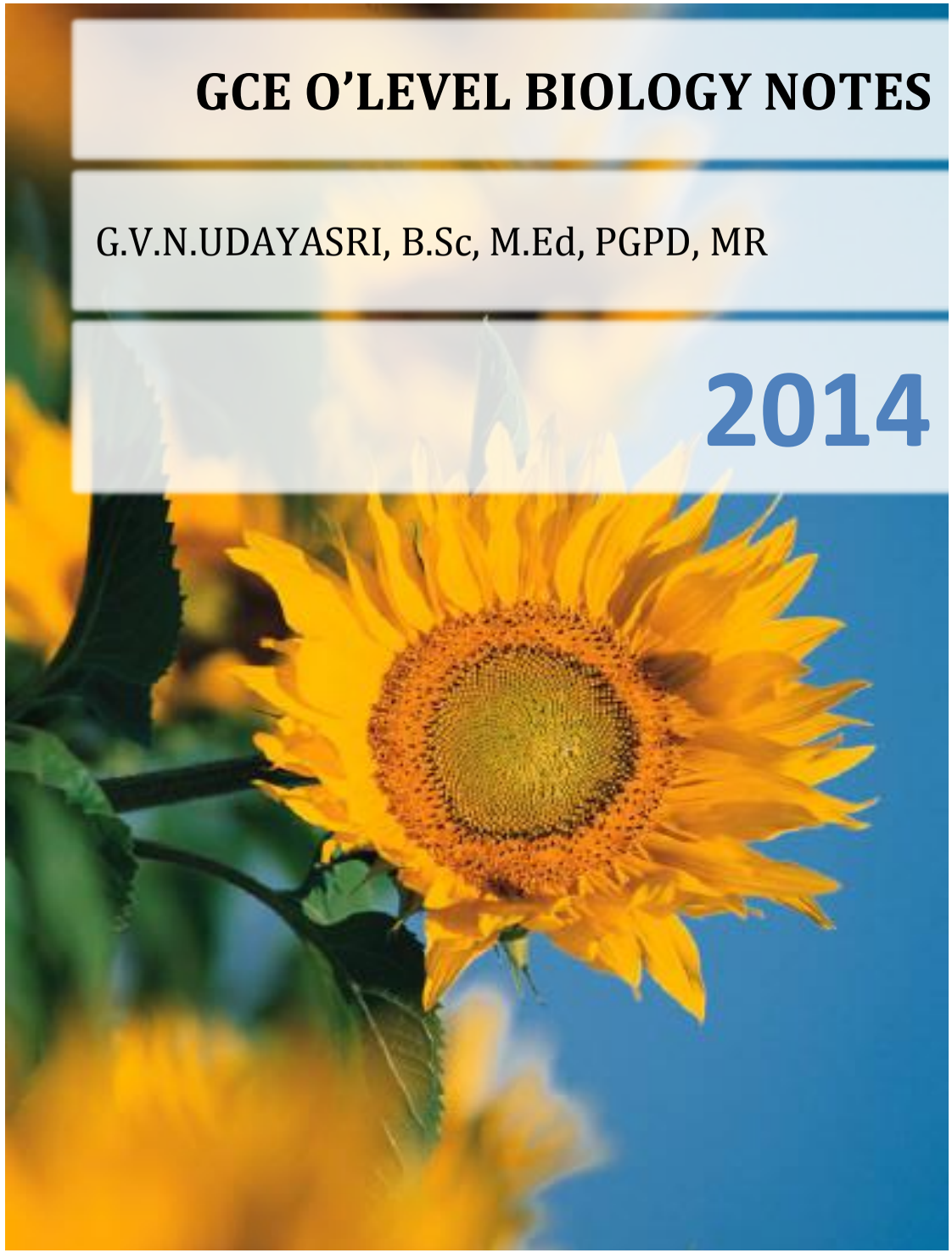


1. **Cell structure and organization:**

1.1 Plant and animal cell **1.2** specialized cells, tissues and organs.

a) Examine under the microscope an animal cell (eg. From fresh liver) and a plant cell (e.g. from Elodea, a moss, onion epidermis, or any suitable locally available material), using an appropriate temporary staining technique, such as iodine or methylene blue.

b) draw diagrams to represent observations of the plant and animal cells examined above

Terms to remember:

Cell: structural and functional unit of cell, responsible for the vital functions

Protoplasm: the cell contents, cytoplasm and nucleus

Cytoplasm: contains all cell organelles, and gelatinous with all chemical molecules dissolved

Nucleus: a spherical dense structure which contains chromosomes, made up of DNA

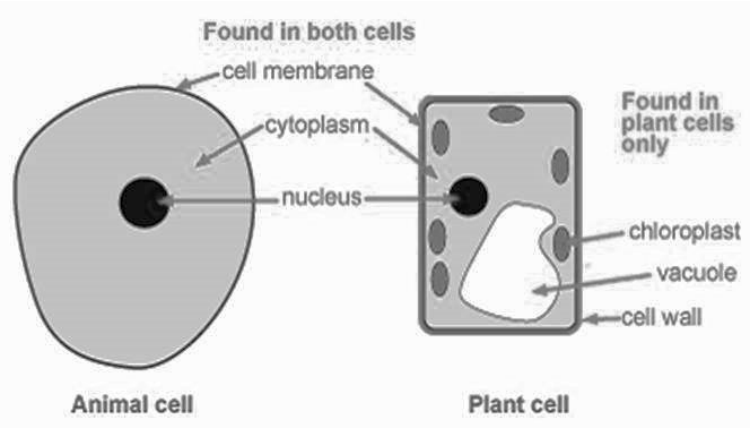
Chloroplast: biconvex organelle, which consist of chlorophyll pigment for light absorption in plant cells

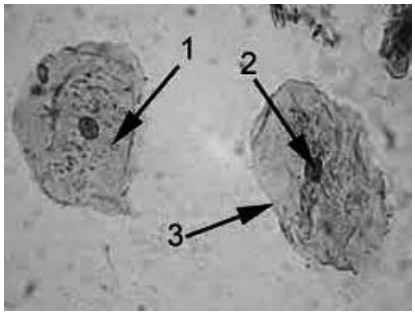
Sap vacuole: large space filled with cell sap, surrounded by tonoplast.

Mitochondria: sausage shaped organelles for cellular respiration in all cells.

Cell membrane: lipid protein layer around the protoplasm, partially permeable.

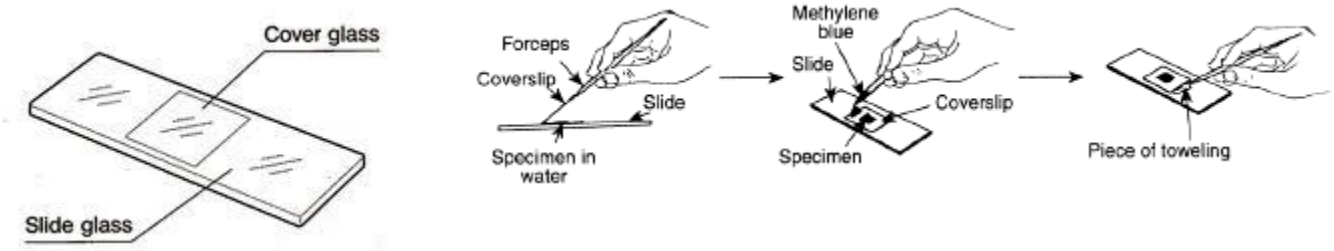
Food storage granules: starch in plants, and glycogen in animal cells.





Preparation of slides to view cells under microscope: (practical 1)

Plant cell slide preparation	Animal cell slide preparation
Take, onion and cut/ take a moss leaf and peel	Take a piece of liver and chop it in mortar/ or use a sterile cotton bud and rub against cheek to take the cells
Use a forceps peel and transfer the small layer and spread it on the glass slide	Transfer the cells by rubbing the cotton bud on glass slide/ take chopped liver and place it on glass slide
Put few drops of iodine on the tissue	Put a few drops of methylene blue on the tissue
Lower a cover slip on the tissue, using a mounting needle carefully to avoid air bubbles	Lower a cover slip using a mounting needle on the tissue carefully to avoid air bubbles
Remove excess stain using tissue paper and press gently.	Remove excess stain using tissue paper and press the cover slip gently
Place the slide on the stage of microscope and adjust low power magnification	Place the slide on the stage of microscope and adjust low power magnification
Adjust the coarse knob to bring the slide closer to the lens till the cells are visible and fine knob to make a clear image.	Adjust the coarse knob to bring the slide closer to the lens till the cells are visible and fine knob to make a clear image



state the function of the cell membrane in controlling the passage of substances into and out of the cell;

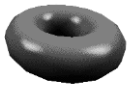
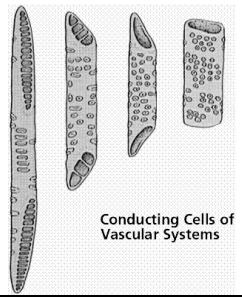
Explain how cell membrane controls the movement of substances in and out of the cell.

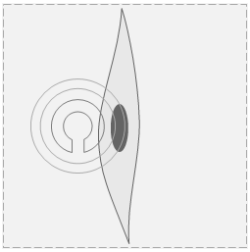
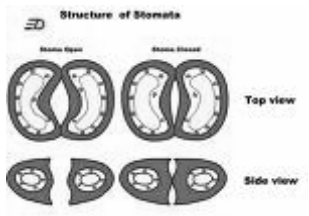
- Cell membrane is made up of lipids and proteins. It is partially permeable.
- That means allows only certain small molecules to pass through.
- It allows the useful substances such as oxygen and glucose enter the cell.
- Waste substances like urea and carbon dioxide diffuse out of the cell.
- Large molecules like storage granules starch and glycogen cannot pass through the membrane and so do not leave the cell.

State the function of cell wall in maintaining turgor (turgidity) with in the cell.

- Cell wall in plant cells is made up of cellulose (a complex carbohydrate) which makes the wall tough and gives strength
- When more water moves into the cell by osmosis, the cell gets turgid, and tough. The cell wall resists the osmotic pressure and prevents the cell from bursting.
- The young plants depend on the cell turgidity to stand firm.
- However in big trees, the xylem vessels provide mechanical support to the trunk.

State, in simple terms, the relationship between cell function and cell structure for the following:

Specialized cell	Structure	Related to function
 palisade mesophyll cell; photosynthesis.	1. Long cylindrical 2. Large number of chloroplasts	1. Can contain more number of chloroplasts. 2. Chloroplast consists of chlorophyll to absorb sunlight for photosynthesis.
Root hair cell; anchor the plant and absorb water and mineral ions. 	1. Cell wall is elongated to hair like extensions. 2. Large vacuole which takes is absorbed water and turgid.	1. This will increase the surface area of the cell to absorb water and mineral ions from soil. The extensions penetrate in between the soil particles and anchor the plant firmly in the soil.
Red blood cell; transport oxygen in the body 	1. Biconcave disc shaped 2. Nucleus is absent 3. Contain haemoglobin	1. Increases surface area .and easily roll in blood 2. Provides more haemoglobin and carry more oxygen 3. Haemoglobin combines with oxygen to form oxyhaemoglobin and give out oxygen to the tissues.
 Xylem vessels; transport and support.	1. Made of dead cells joined end to end. 2. Cell walls lined with lignin	1. No cytoplasm and nucleus make the vessel hollow to conduct water. 2. Provides mechanical support to the vessel and to the stem.

 **nerve cell- conduct impulses**	**sperm cell; have half number of chromosomes**  **and fertilize with ovum.**	**muscle cell; contract and**  **causes movement .**	**guard cells; control the**  **opening and closing of stomata.**

Differentiate *cell*, *tissue*, *organ* and *organ system* as illustrated by examples covered in sections 1 to 12, 15 and 16.

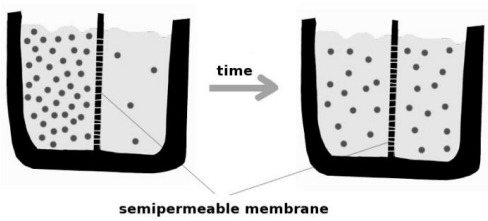
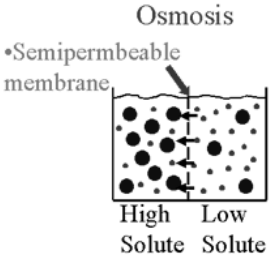
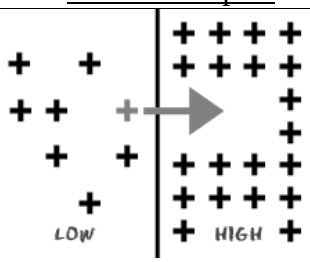
- Cell: the basic structural and functional unit of all organisms. Responsible for metabolic activities.
- Tissue: group of similar cells performing a specific function forms a tissue. Example: mesophyll tissue of leaf, vascular tissue of plants, muscle tissue, blood tissue…..
- Organ: group of tissues forms an organ and perform a function. Example: heart, lungs, leaf, stem, etc..
- Organ system: group of organs performing a particular function in the body. Example: circulatory system, respiratory system, root system, shoot system in plants, etc.

2. Diffusion and osmosis

(a) Define *diffusion as* the movement of molecules from a region of their higher concentration to a region of their lower concentration, down a concentration gradient;

(b) Define *osmosis* as the passage of water molecules from a region of their higher concentration to a region of their lower concentration, through a partially permeable membrane;

d) define *active transport* as the movement of ions into or out of a cell through the cell membrane, from a region of their lower concentration to a region of their higher concentration against a concentration gradient, using energy released during respiration

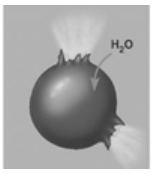
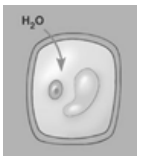
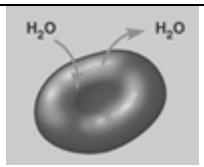
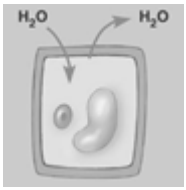
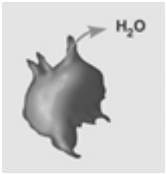
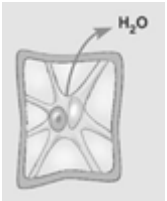
Diffusion	Osmosis	Active transport
		
Molecules move from their higher concentration to lower concentration down the concentration gradient.	Water molecule move from high water potential solution region to low water potential region through a partially permeable membrane.	Molecule move from lower concentration region to higher concentration region, against the concentration gradient.
No energy is required	no energy is required	Energy produced during respiration is needed.
Example: small molecule such as carbon dioxide, oxygen, glucose….	Example : water molecules	Ions such as nitrates, magnesium, photsphate….

Water potential: ability of water molecules to leaves a solution.

- ✓ Strong solutions (concentrated solutions – low water potential)
- ✓ Dilute solutions and pure water- high water poteintial.
- ✓ Water potential depends on the amount of the solute mixed in the solvent
- ✓ Water moves from soil to root hair cells by osmosis
- ✓ From xylem to mesophyll cells

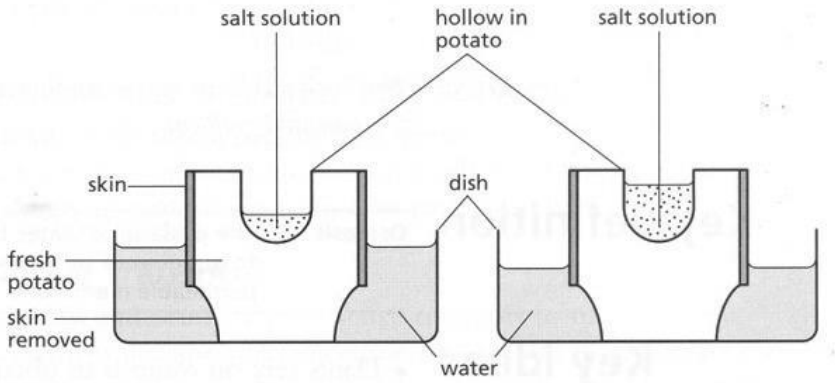
(c) Describe the importance of a water potential gradient in the uptake of water by plants and the effects osmosis on plant and animal tissues;

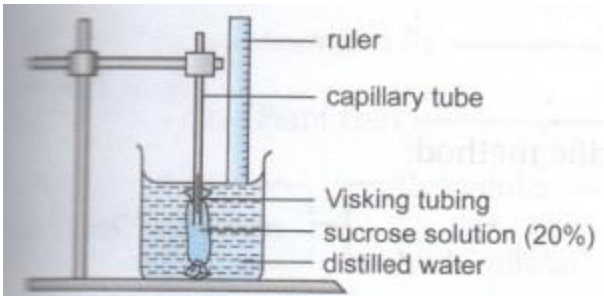
Water potential gradient is important in plants to absorb water from soil through root hairs and transport it from cell to cell with in the plant. In animals also it is important to control the amount of water in the bodies and in intercellular transport and maintain osmoregulation in living cells.

	Animal cell	**Plant cell**
cells placed in distilled water or solutions that have less concentration than the cell cytoplasm	*Water molecules are more out side the cell. *They move into the cell by osmosis through the cell membrane into the cell.  * Cell gains more water and burst (haemolyzed) because animal cells do not have cell wall to resist osmotic pressure.	*water molecules in side the cell are less than out side. * They move in to the cell by osmosis through the cell membrane.  * cell gains water , vacuole swells, and cell wall resists pressure make the cell turgid.
Cells placed in solutions that have same concentration than	no concentration gradient between the cell cytoplasm and solution . no net movement of molecules of water. Cell remains same. 	no concentration gradient between the cell cytoplasm and solution. no net movement of molecules of water. Cell remains same. 
Cells placed in solutions that have high Concentration that cell cytoplasm	*Water molecules are more in side the cell than out side. *They move out of the cell by osmosis through the cell membrane into the cell.  * Cell loses more water and shrinks (crenated) because animal cells do not have cell wall to resist osmotic pressure.	*water molecules in side the cell are more than out side. * They move out of the cell by osmosis through the cell membrane.  * cell loses water , vacuole shrinks,cell membrane is pulled away from cell wall and the cell gets flacid (shrink)

Practical 2: Investigating osmosis in plant tissues:

* In the experiment salt solution level increased in the hollow potato.
* Water from beaker enters the potato cup by osmosis.
Explanation for the result:

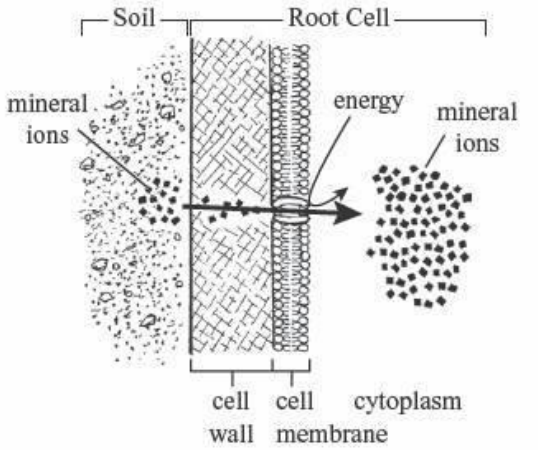




Observation: the level of liquid in capillary tube rises. Water level in the beaker decrease (fall).
Explanation: inside the visking tubing sucrose concentration is more and so less water molecules present. Hence water from the beaker enters in to the visking tubing by osmosis through the tubing membrane.

(e) Discuss the importance of active transport as an energy-consuming process by which substances are transported against a concentration gradient, as in ion uptake by root hairs and glucose uptake by cells in the villi.

Active transport of ions from soil to the root hair cells: The size of root hair cell is small and ions dissolved in the cytoplasm are more concentrated than the ions dissolved in soil water. Roots absorb oxygen and respire to produce energy. This energy is used to take up the ions from soil by the root hair cells. Without this active transport mechanism plant would not be able to absorb mineral ions needed for their growth. Plants growing in soil with less oxygen respire less and produce less energy (ATP). This would reduce the ion uptake and plant growth would be reduced.



Active transport of glucose amino acids in human intestine: carbohydrates and proteins are digested to simple molecules glucose and amino acids. There are diluted in the intestine as it is very long and have large area. From the ileum lumen to cells of villi (finger like projections of the inner wall of intestine) glucose and amino acids move by active transport.

3. ENZYMES

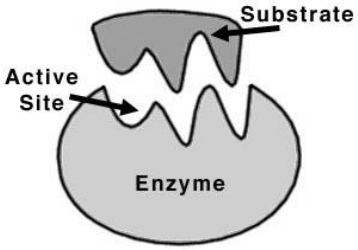
(a) Define *catalyst* as a substance that speeds up a chemical reaction and is not changed by the reaction;

Catalyst is a chemical that speed up the chemical reaction. It is not changed by the reaction and remains the same.

(b) Define *enzymes* as proteins that function as biological catalysts;

Enzymes are group of proteins act as biological catalyst. They catalyze metabolic reactions in the living cells and speed up chemical reactions. The chemical reaction may include the synthesis of large molecules from small such as photosynthesis and protein synthesis (anabolism) and of breaking down of large molecules to simple form such as respiration and digestion (catabolism). Enzymes being proteins sensitive to pH and temperature. They work best at optimum temperature and pH.

(c) Explain enzyme action in terms of the 'lock and key' hypothesis;



*Enzyme molecules have specific sites for the substrate molecules to bind, called as active sites.
* These active sites are complementary to substrate molecules (a chemical molecule that is undergoing a chemical reaction is called substrate) So that a substrate molecule can fit into the active site.
* The enzyme acts as lock and allows a specific substrate to fit into it. The substrate is like a key which fits into a specific lock.
* When the substrate binds with active site of enzyme the chemical reaction occurs faster to produce products.

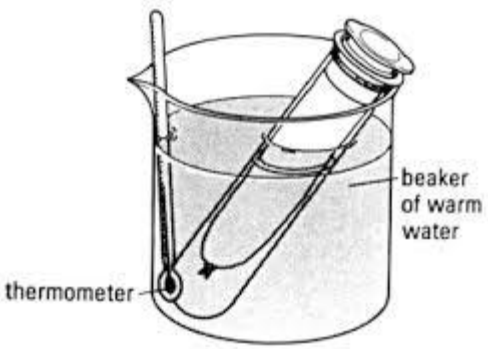
Example of some enzymes that work in human digestive system:

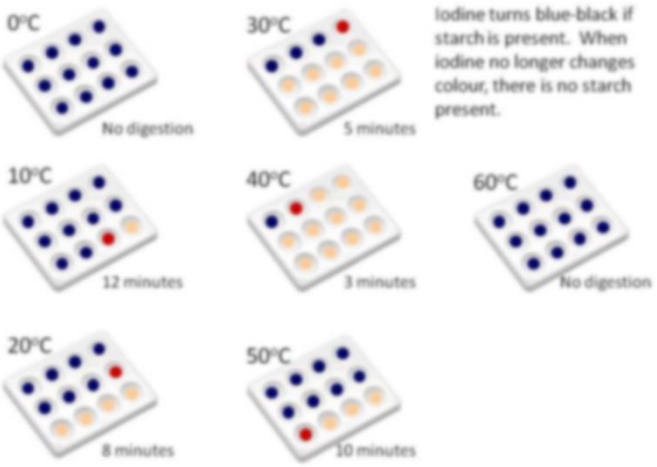
Enzyme	Substrate	Product	Optimum pH	Active in part of the alimentary Canal
Amylase	Starch (complex carbohydrate)	Maltose (simple sugar with two smaller units)	Neutral (7 to 8)	In mouth and duodenum
Pepsin	Protein	Peptides and amino acids	Acidic (2 to 5)	In stomach as it contains HCl
Trypsin	Protein	Amino acid	Neutral (7-8)	duodenum
lipase	Fats (lipids)	Fatty acids and glycerol	Neutral (7-8)	Duodenum.

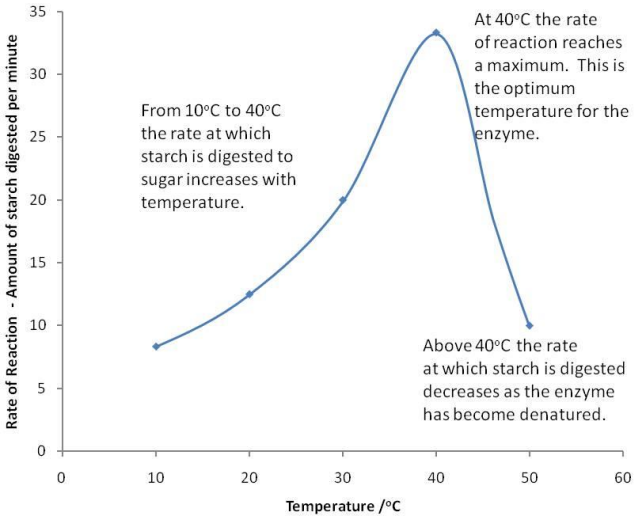
(d) Investigate and describe the effect of temperature and of pH on enzyme activity.

Experiment 1: To investigate the effect of temperature on enzyme activity: Take 1% starch solution of 10 cm^3 in a boiling tube and pippete 2 cm^3 of 1% amylase solution into it. Place this boiling tube in water bath set at 10^o C. Start the stop watch and after every minute take few drops of reaction mixture and test with iodine in a cavity tile. Record the time taken for the starch to digest into sugar. Repeat the experiment with other temperatures.

Observation: observe the time taken for the reaction mixture failed to give blue black colour. (initially when the starch is not digested, the reaction mixture turns blue black, when all the starch is digested; solution remains yellow brown when tested with iodine)





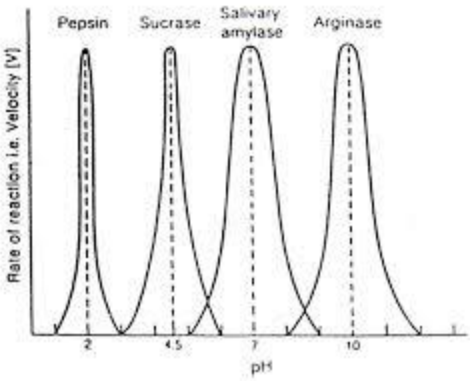


Data analysis: the results can be recorded on graph to check the optimum temperature of this enzyme to work best.

Explanation: an increase in 10^0 C temperature increases the rate of reactions (enzyme activity) to double this is because the molecule to get kinetic energy with increase in temperature and more substrate can collide and bind with the enzyme active sites. So more product forms. The rate of reaction increases up to the optimum temperature and further the rate decreases. Since enzymes are proteins they denature at high temperatures. Means the active site deforms and substrate can no longer binds with active site to form product.

2. Experiment to investigate effect of pH on enzyme activity.

As mentioned in experiment 1, take enzyme and substrate in the boiling tube and add buffer solution (acid or alkali of various pH) to the reaction mixture. Record the time taken to the substrate digest. Observe at which pH the reaction occurs fast. Draw graph to analyze results. Each specific enzyme works best at a particular pH and it is called its optimum pH. See the figure beside the different pH at which different enzyme work.



4. Plant nutrition

Learning outcomes

(a) understand that photosynthesis is the fundamental process by which plants manufacture carbohydrates from raw materials;

Photosynthesis: is a process by which all green plants synthesize carbohydrates (glucose) using raw materials such as carbon dioxide from air, and water from soil. This chemical reaction uses solar energy absorbed by the chlorophyll present in the leaf cells.

(b) explain why most forms of life are completely dependent on photosynthesis

During this process glucose produced is converted to starch and is stored in leaves and other storage organs of the plant. It is also a source of food for other organisms. That is why plants are called the producers in terms of ecology. The plant uses the carbohydrates to produce energy during respiration, which is important to its metabolism such as protein synthesis, enzymes and hormones necessary for growth. The oxygen released is a bye product and released out of the leaves and is useful for the other organisms to breathe. Hence this process is important for the plant growth as well as the other organisms and to maintain oxygen concentration in the atmosphere.

(c) State the equation (in words or symbols) for photosynthesis;

$$\text{Carbon Dioxide + Water} \xrightarrow[\text{Chlorophyll}]{\text{Light}} \text{Glucose + Oxygen}$$

$$6CO_2 + 6H_2O \xrightarrow{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$$

(d)) understand that chlorophyll traps light energy and converts it into chemical energy for the formation of carbohydrates and their subsequent storage;

During photosynthesis plants use light energy from the Sun. this light energy is absorbed by chlorophyll, a pigment present in the organelle chloroplast of leaf mesophyll cells. The light energy absorbed thus powers the photosynthesis reactions and is converted to chemical form (glucose). Glucose is a simple carbohydrate that can be soluble and diffuse to adjacent cells and used up in respiration to produce energy. So the glucose molecules are converted to complex form starch and are stored in the leaves, and other storage organs of plant (root, stem and tubers). The carbohydrate can be converted to other simple molecule sucrose and is transported from leaves to stem, root and from back to leaves under special conditions.

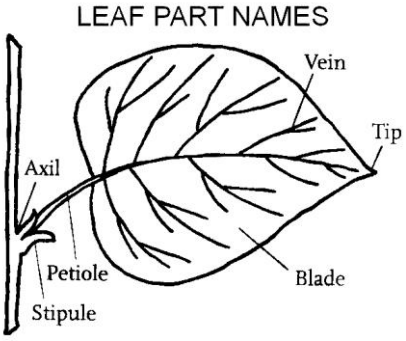
(e) describe the intake of carbon dioxide and water by plants; Carbon dioxide is taken into the leaf mesophyll cells thorough stomata (pores) present on the surface of the leaf. The gas diffuses in down the concentration gradient. Water is absorbed by root hairs and is conducted to the leaf by xylem vessels.

(f) identify and label the cuticle, cellular and tissue structure of a dicotyledonous leaf, as seen in cross-section under the microscope, and describe the significance of these features in terms of function, i.e.

• Distribution of chloroplasts – photosynthesis; the palisade mesophyll cells consists of large number of chloroplasts. These cells are just beneath the upper epidermis and so absorb light efficiently and photosynthesize. The spongy mesophyll cells have less number and guard cells have few.

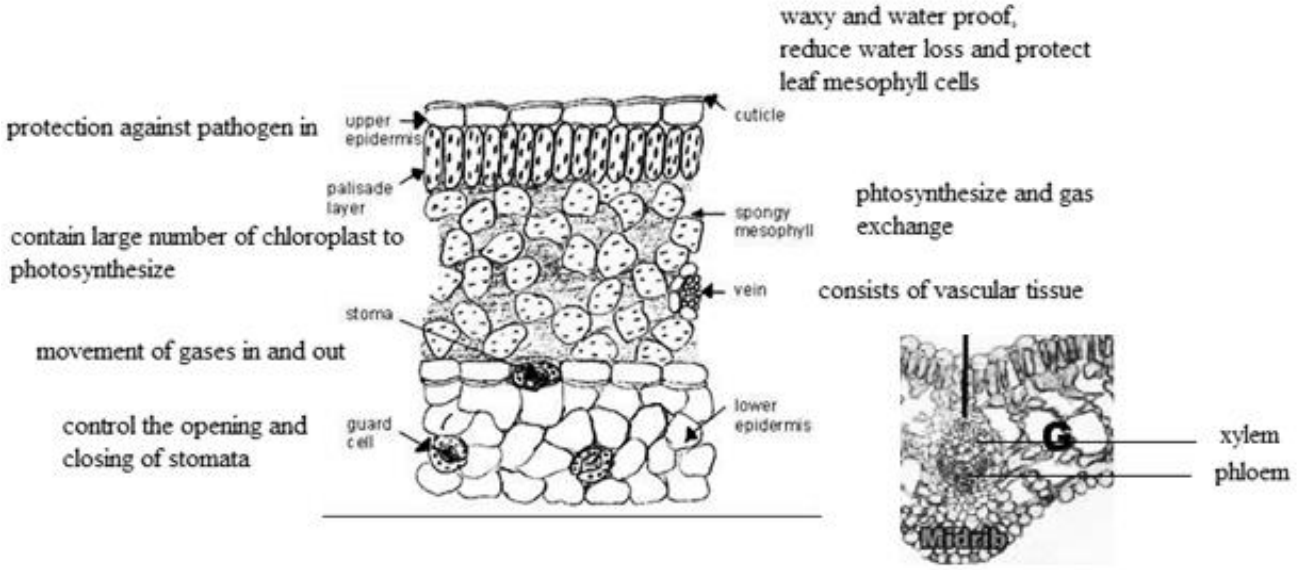
• Stomata and mesophyll cells – gas exchange; Most dicotyledonous plant leaves have stomata on their lower surface in large number and few or none on upper surface. The spongy mesophyll cells are packed irregularly leaving air spaces in between. The oxygen released during photosynthesis moves into the air spaces from mesophyll cells and diffuses out down the concentration gradient. Carbon dioxide enters the air spaces from the atmosphere through stomata. From there it diffuses to mesophyll cells and used for photosynthesis.

• Vascular bundles – transport; the mid rib and veins of the leaf consists of vascular bundles with xylem and phloem tissue. The xylem is situated to towards the upper epidermis in the vascular bundle and transport water from roots to leaf. The phloem vessels transport the food synthesized by the leaf to the other parts of the plants.



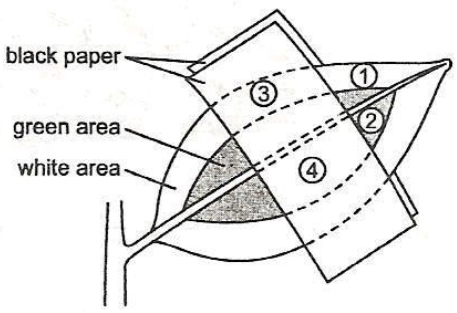
The external structure of leaf is adapted to get all the raw materials and light needed for photosynthesis. The broad leaf blade (lamina) increases the surface area for more light and carbon dioxide absorption. If the blade has large surface more number of stomata are present. The mid rib and veins consists of vascular bundles. Xylem vessels bring water to the leaf. The arrangement of leaf facing facilitates light absorption.

The following figure shows the cross section of leaf (internal structure)



g) Investigate the necessity for chlorophyll, light and carbon dioxide for photosynthesis, using appropriate controls;

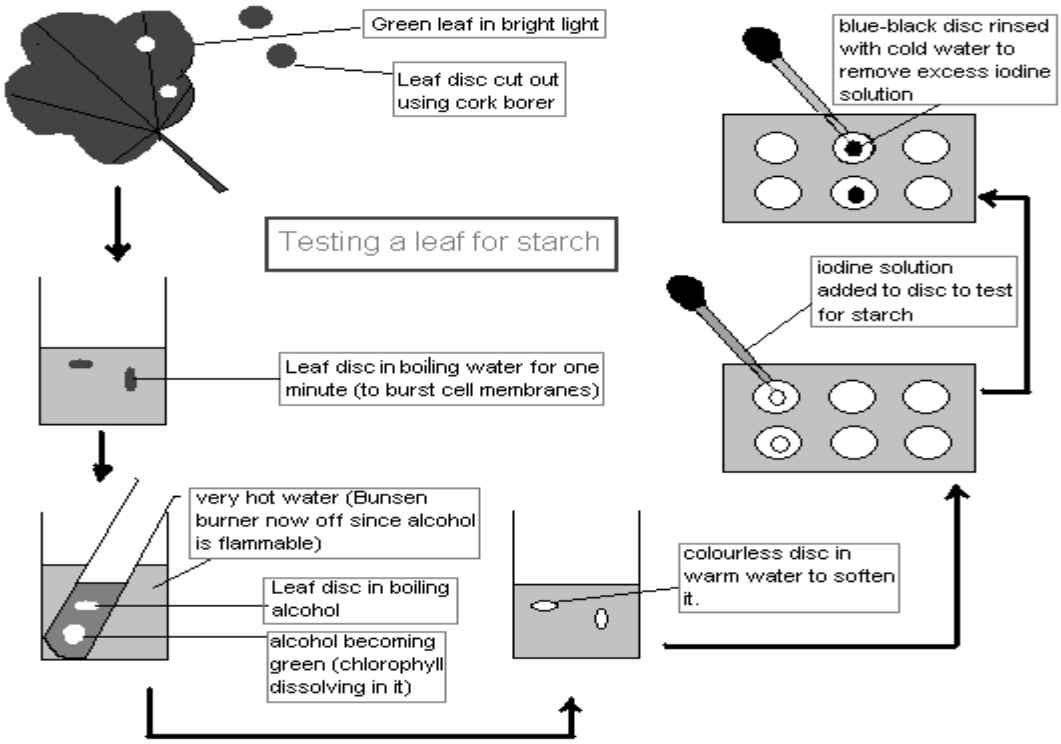
- In the leaf illustrated the area numbered as **4,** is covered with a light proof paper so that light cannot reach the cells. The area numbered as 2 acts as control to compare the results of experimental area 4. A control is normally provided with all factors needed for the process.

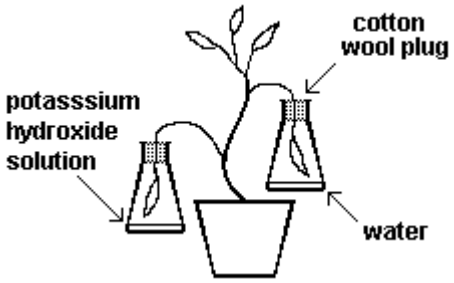


- The area numbered as **3** is used to check the need of chlorophyll, since this area is non-green. This area is also compared with area 2, as it has chlorophyll.

Observation: the leaf can be destrached before the experiment means starch prepared previously should be removed. Destarching can be done by keeping the potted plant in dark for about 36 to 48 hours. During this period the starch present is converted to glucose and is used by the plant for respiration. This ensures fair results of your experiment. The plant is kept in sun light for few hours and the leaf areas are tested for starch.
Disc 1: is not having chlorophyll but provided with light. When tested with iodine remains brown.
Disc 2: have all factors and shows positive result with iodine tests, showing the presence of starch.
Disc 3: chlorophyll is missing; so gives negative results with starch iodine test.
Disc 4: light is missing, so this area of leaf cannot photosynthesize and no starch is produced.

Refer the following diagram to know the practical details of testing a leaf for starch. Iodine turns starch to blue black.





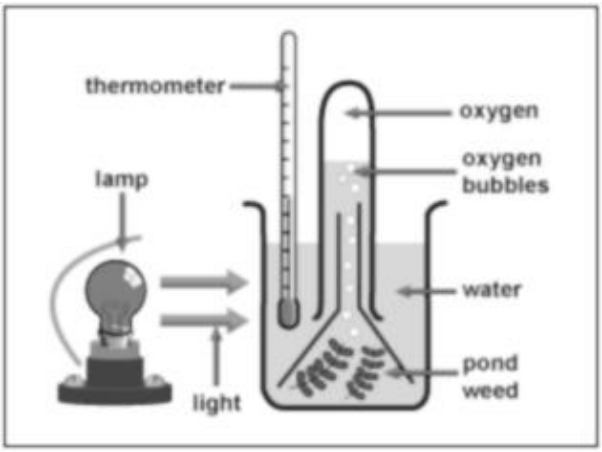
Investigating the need of carbon dioxide: Set the apparatus shown beside. The flask with potassium hydroxide acts as experiment. This chemical absorbs any CO_2 in the flask so that the leaf does not get CO_2. The flask with water acts as control as it has CO_2 in the flask for the leaf to absorb. Leave this plant in sun light for few hours and test the leaves for starch. The leaf without CO_2 shows negative results with iodine, (does not turn blue black)

(h) Understand the concept of limiting factors in photosynthesis;

If any factor supplied in short reduces the rate of the process, even all other factors are provided in optimum, such factor is called as limiting factor. Eg. The plant is provided with sufficient light, optimum temperature but low carbon dioxide levels; the process of photosynthesis slows down. Light intensity, carbon dioxide concentration and temperature are the limiting factors of photosynthesis. If any of these factors are not in optimum amount of carbohydrates (glucose) produced will be less.

(i) Investigate and state the effect of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis (e.g. in submerged aquatic plants);

Rate of photosynthesis means the speed at which the process occurs in a given time. How fast the plant photosynthesizes can be measured by the amount of oxygen produced by the plant.
Since it is difficult to measure the oxygen given out by a terrestrial plant, an aquatic plant can be used to investigate the rate of photosynthesis under various limiting factors.
The set up shown beside can be used to test the effect of limiting factors on rate of photosynthesis.

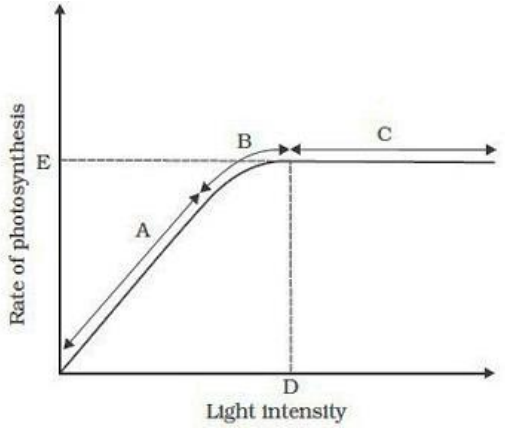


- CO_2 concentration and rate of photosynthesis: dissolve 1 g of hydrogen carbonate as a source of carbon dioxide, in the water. Provide optimum light and temperature for the process to occur. Observe the number of oxygen bubbles evolved in 5 minutes. Record the number of bubbles in table.

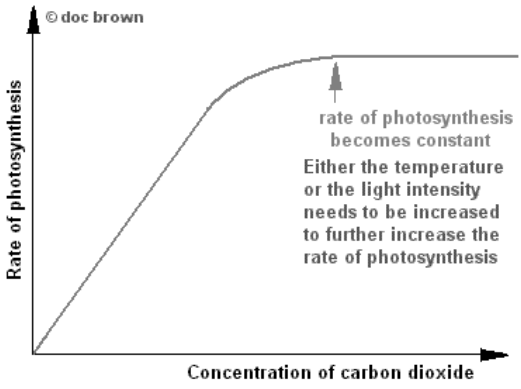
Repeat the experiment by dissolving 2g, 3g 4g and 5 g of hydrogen carbonate to increase the concentration of carbon dioxide. And tabulate the results.

- To investigate the effect of light intensity on the rate of photosynthesis. You can use the apparatus by changing the position of the light at different distances and observe the number of oxygen bubbles produced at each light intensity.

Increased light intensity and carbon dioxide concentration increases the rate of photosynthesis, until another factor limits the process. After saturation point, further increase in factor does not increase rate further. The rate becomes constant as the leaf cells are saturated and cannot absorb any more. *The gas evolved can be tested by using a glowing splint, and if rekindles it proves the gas is oxygen.*



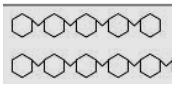
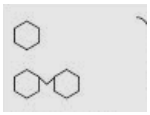
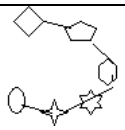
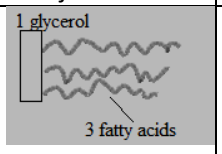
(j)



Understand the effect of a lack of nitrate and magnesium ions on plant growth.

Mineral element/ form absorbed	Used for	Deficiency symptoms
Magnesium This element is absorbed in the form of magnesium ions and compounds.	The synthesis of chlorophyll. So that light absorption is maximum.	Leaves turns yellow; this condition is called chlorosis.
Nitrogen this element is absorbed in the form of nitrates.	Nitrogen is uses in the synthesis of proteins needed for growth. Proteins include enzymes, hormones and DNA.	Plant growth is stunted. Leaves turns yellow. Poor growth in leaves and stem reduces productivity.

5. Animal Nutrition: chemical elements present in carbohydrates, fats, proteins and roughages.

Nutrient	Elements	Used for	Structure	Complex form	Simple molecule
Carbohydrate Cereals, bread, honey Potatoes, etc.	(carbon, hydrogen and oxygen)	Respiratory substrate, to produce energy	 many glucose molecules join.	Starch; glycogen & cellulose	Glucose; simplest.  (maltose, sucrose and lactose are disaccharides)
Protein Meat, fish, eggs and milk	;(carbon, hydrogen, oxygen and nitrogen and phosphorous)	Needs for growth and repair of tissues(enzymes, hormones)	 many amino acids join.	Called as polypeptides	Single units called amino acids
Fats/lipids Milk , cheese, meat, oils etc.	Carbon, hydrogen and oxygen	Energy storage, insulation Protect vital organs like kidneys		Triglycerides	Fatty acids and glycerol
Roughages Green leafy vegetables, whole grains..	Carbon, hydrogen and oxygen	not digested, but helps in egestion by easy peristalsis	Plants cells have cellulose a complex carbohydrate.	Cellulose	glucose
Water	Hydrogen and oxygen	Lubrication and hydrolysis.	-	-	-

Mineral / source	Use	Deficiency symptoms
Iron Red meat, spinach and greens	Used in the synthesis of haemoglobin in red blood cells	Anemia. Tiredness, pale skin, and shortness of breath.
Calcium Milk, and salmons	Formation of healthy bones and teeth**.**	Rickets; twisted bones, soft bones , bow legs and week bones.

vitamin / source	Use	Deficiency symptoms
C Red meat, spinach and greens	Used the in formation of healthy tissues and gums	Scurvy; bleeding gums, poor wound healing,
D Sunshine vitamin, our body can synthesize it in sun shine	Formation of healthy bones and teeth**.**	Rickets; twisted bones, soft bones, bow legs and week bones.

(b) Describe tests for:
• starch (iodine in potassium iodide solution);
• reducing sugars (Benedict's solution);
• protein (biuret test);
• fats (ethanol emulsion test);

Food	Reagent used	Immediate colour	Result
Starch	Iodine solution (yellow brown)	Food sample turns to yellow brown	If starch present the sample turns to blue black. If there is no starch present solution remains brown.
Reducing sugar (glucose, maltose and lactose)	Benedict's reagent (blue in colour)	Food sample turns to blue	The reaction mixture should be heated in water bath. Using of water bath distribute the heat uniformly to the sample. It is also safe so that directing heating on burner is avoided. Solution turn to blue→ green→ yellow→ orange (brick red) showing the concentration of sugar. If no sugar present solution remains blue.
Protein	Biuret reagent(blue)	Food sample turns to blue	If protein present the solution turns to purple colour. (lilac/violet), If protein absent solution remains blue.
Fats	Ethanol is added to the reaction mixture first and then water is poured over the sample	Gets clear solution	If fat present there will be a white cloudy emulsion seen. If fat is absent solution remains clear.

* Note: for all the tests apparatus and quantities of food sample to be mentioned. Volumes of reagents added and method of transferring them to the boiling tube also to be mentioned. (Practical details).

(e) Understand the concept of a balanced diet; The diet that contains all the 7 classes of foods in required proportions is said to be balanced diet. Lack of nutrient or short supply leads to deficiency symptoms and is called malnutrition.

(f) Explain why diet, especially energy intake, should be related to age, sex and activity of an individual; The diet we take should meet the body needs.

- ✓ Children should take more energy diet as they have high basal metabolic rate. More energy is needed for the growth and synthesis of proteins and cell division to develop new tissues and bones. They also have to take minerals and vitamins in good amounts in diet.
- ✓ Females after puberty should take more iron rich diet to replenish menstrual losses.
- ✓ The individual doing physical activity and hard labor should take more energy diet because more calories are spent in doing work.

(g) state the effects of malnutrition in relation to starvation, heart disease, constipation and obesity;

Any nutrient taken in less or more than required is termed as malnutrition.

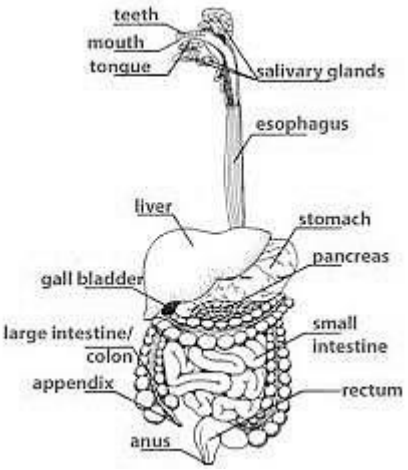
- Lack of nutrients in the diet than required amounts leads to poor growth such as kwashiorkor or marasmus. Lack of minerals such as iron leads to anemia and vitamin C leads scurvy.
- Diet taken in excess of carbohydrates and fats leads to obesity. This is because the energy spent is less than the energy taken in diet. The excess fats are stored under the skin causes obesity. The cholesterol deposits on the walls of arteries.
- Increased body weight increases blood pressure to pump blood all over the body. High pressure in arteries might damage blood vessels and leads to blood clotting in arteries. Finally this results in blockage in arteries and cause heart diseases.

(h) Discuss the problems that contribute to famine (unequal distribution of food, drought and flooding, increasing population);

In extreme climatic conditions (lack of rains and desertification) and due to natural calamities (droughts and famine), destruction of crops leads to shortage of food. The unequal distribution of food to the increased population leads to malnutrition among populations of the nations.

(i) identify the main regions of the alimentary canal and the associated organs: mouth (buccal) cavity, salivary glands, esophagus, stomach, duodenum, pancreas, gall bladder, liver, ileum, colon, rectum and anus;

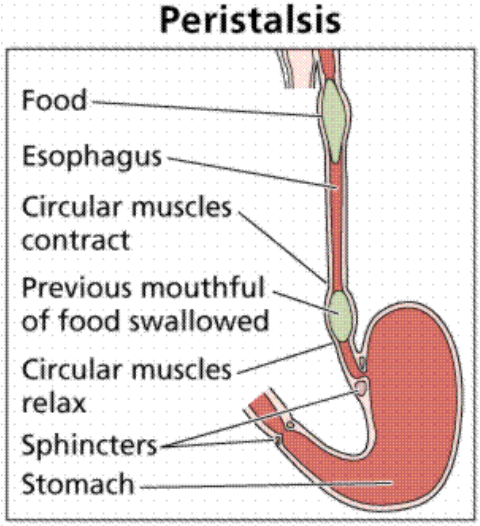
(j) describe the main functions of these parts in relation to ingestion, digestion, absorption, assimilation and egestion of food, as appropriate;



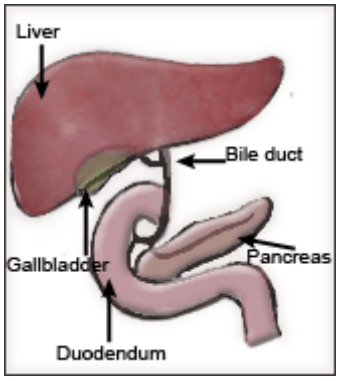
Ingestion: taking in of food into the alimentary canal is ingestion. The first part of the alimentary canal called as mouth is used in ingesting food. There are 3 pairs of salivary glands in the mouth (Buccal cavity) which secrete saliva. The saliva consists of an enzyme salivary amylase.

Digestion: the process of breaking down of complex food molecules to simple soluble form is called digestion. Most foods that are complex to be digested to simple so that they cab absorbed into the blood. The blood circulates the digested foods to all body tissues. The body tissues use the food to produce energy and growth.

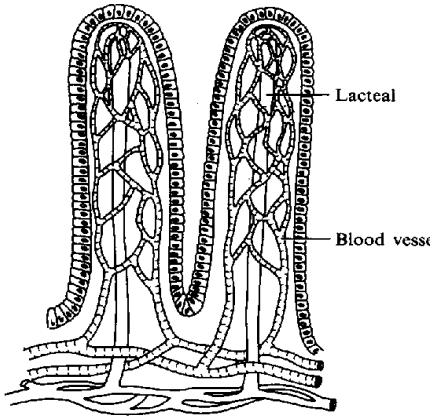
- In the *mouth* carbohydrates (starch) is digested partly by salivary amylase and small molecules of carbohydrates (maltose) are formed. Food is chewed with the help of teeth and made into a bolus.
- The mouth opens into pharynx (common passage for trachea and oeosphagus). Food from mouth passes into the oeosphagus. The antagonistic action (one muscle contract one muscle relax) of the esophageal muscles pushes the food bolus into the stomach. The circular muscles above the food bolus contract and longitudinal muscles in this region relax. This pushes the food bolus down. There is no enzymes secretion in mouth.



- The stomach is a muscular bag. The lining of stomach secretes gastric juice, which consists of Hydro chloric acid and a protease, pepsin. The acids in the stomach kill the pathogens present in the food. Pepsin acts on proteins and digest them into short chains of peptides.
- The sphincter muscles at the start and end of the stomach control the entry and exit of food.
- The first part of the small intestine is called as duodenum. The liver and pancreas are connected to the duodenum. The lever secretes bile juice is alkaline and contain bile salts. The bile temporarily stored in gall bladder and is released into the duodenum by bile duct. The bile juice neutralizes the acidic chime and provides optimum pH for the enzymes.



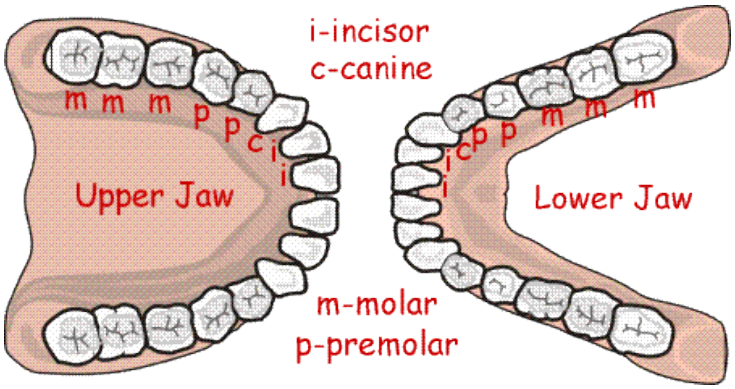
- In duodenum fats, proteins and starch are digested by the action of pancreatic enzymes. Pancreas secretes pancreatic juice into the duodenum. Pancreatic juice contains amylase, trypsin and lipase. Starch is digested to maltose by amylase. Trypsin is a protease that works at neutral pH and digests the proteins to amino acids in the duodenum. Fats are emulsified by bile into small fat globules. Enzyme lipase acts on the emulsified fats and digest them into simple fatty acids and glycerol.

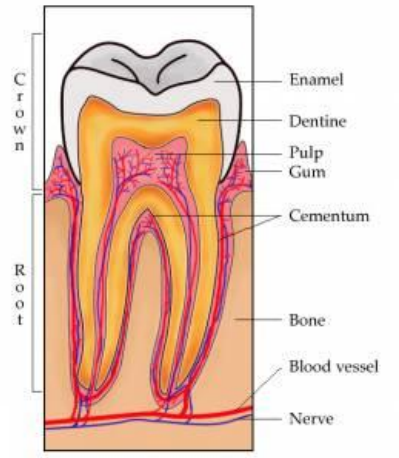


- The food digested in the duodenum is then passes into the ileum, the second part of the small intestine. The inner wall of intestine is folded into finger like projections called villi. This increases the surface area of the ileum. The walls of villi are single cell thickness so that the digested end products are absorbed into the blood rapidly. The cells of villi consist of microvilli which further increase the surface area. The villi are supplied with blood vessels and lacteals. Maltose is further digested to glucose by enzymes secreted by ileum wall. The glucose and amino acids in the ileum lumen are diluted and so move into the cells of villi by active transport. From the cells of villi they diffuse into the blood capillaries. Fatty acids and glycerol diffuse into the lacteals. Lacteals belong to the lymphatic system and carry the fats and empty them in the vena cava. <u>The process of the movement of digested products into the blood is called as absorption.</u>

- The digested end products are carried to the liver by hepatic portal vein (gut to liver). <u>The process of using the digested end products for metabolism and storing them for further use, is called assimilation.</u>

<u>Identify the different types of human teeth and describe their structure and functions; state the causes of dental decay and describe the proper care of teeth;</u>





$$i\ \frac{2—2}{2—2},\ c\ \frac{1—1}{1—1},\ b \text{ or } pm\ \frac{2—2}{2—2},\ m\ \frac{3—3}{3—3} = 32$$

Incisors – there are four in the upper jaw and four in lower and they help in cutting and biting food. [8]
Canines- there are two on either side beside the incisors in upper and lower jaw, sharp and pointed to tear the food.[4]
Premolars – two on either side of canines in upper and lower jaw used in grinding and chewing food. [8]
Molars- three on either side of the premolars, in lower and upper jaw, used in grinding and chewing food. This activity of chewing increase the surface area of food molecules so that enzymes can act efficiently and easy to swallow (12)
<u>Dental care</u>: dental decay occurs if bits of food remain in between the teeth. The bits of food, and sugars formed when food is chewed and partly digested allow the bacteria to feed and release acids in the mouth. All these components form a coating on the crown on tooth. This is called as plaque. Initially the plaque has no much effect on the tooth, but slowly the acids in plaque destroy the enamel. During this time pain is not felt, but as the decay extends to the pulp, leaving cavity in the tooth and causes pain. The nerve ending the root of the tooth detects pain. To prevent the dental decay one should brush the teeth twice a day, and rinse the mouth after each sugary meal. Fluoride containing tooth pastes heal the gums and increase the pH in the mouth neutralizing the acids. This reduces the dental decay. Dental floss and consulting the doctor when needed helps to maintain good dental health.

<u>Assimilation</u>: Liver plays an important role in the assimilation of digested food. From the food transported to liver thorough hepatic portal vein the excess glucose molecules are converted to glycogen (complex carbohydrate) for later use.

- The amino acids transported to the tissues are used in synthesizing proteins needed for growth. Excess amino acids cannot be stored and so deaminated in the liver to form urea. The urea is transported to kidney so that it can be excreted.

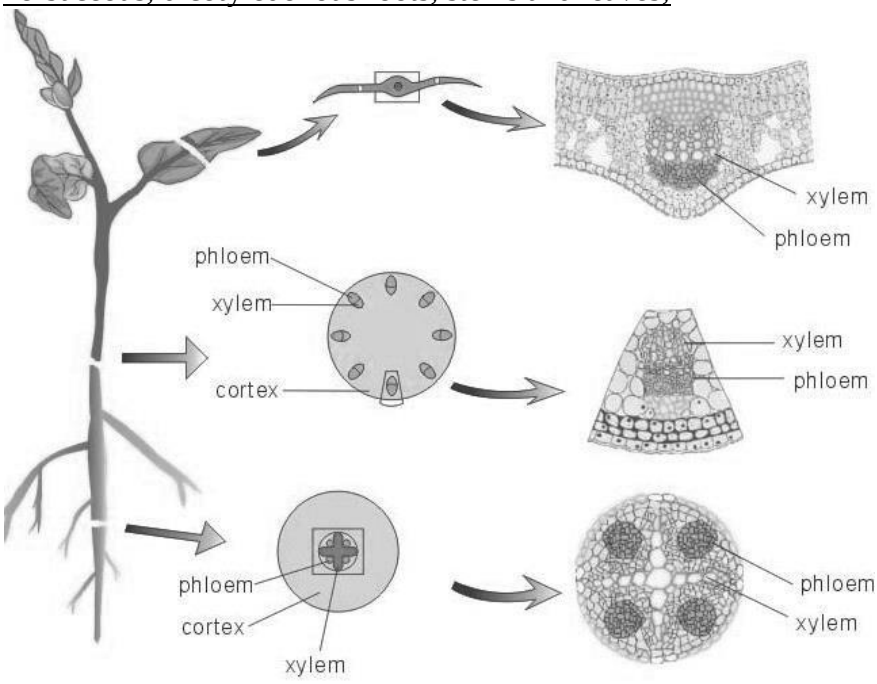
- The fatty acids and glycerol are converted to fats and are stored in adipose tissue beneath the skin and some in liver. Fats acts as energy store and are used under starvation conditions to provide energy. They insulate the body and protect the vital organs.
- The liver also break down the alcohol consumed and detoxify it. (makes harmless)

6.Transport in Plants:

a) relate the structure and functions of root hairs to their surface area and to water and ion uptake;

The cell wall of the root hair cell is extended to a tubular hair and increases the surface area of the cell. The cell membrane which is selective permeable allow the movement of molecules of water and ions. Water enters the cells by osmosis and ions enter in by active transport.

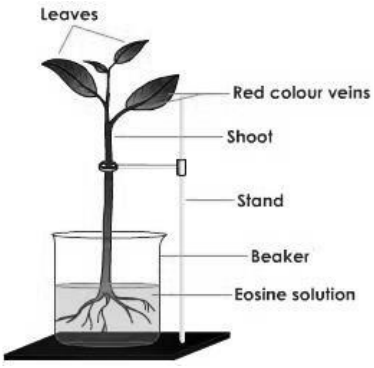
b) Identify the positions of xylem and phloem tissues as seen in transverse sections of unthicken, herbaceous, dicotyledonous roots, stems and leaves;



Distribution of vascular tissue in dicot leaf, stem and root

c)State the functions of xylem and phloem: **Xylem** vessels are the tissue that conducts water and mineral ions from roots to leaves. They are tubes connected from root to leaves through stem continuously to allow the flow of water. (See topic 1 for the specialization of this tissue). They also provide mechanical support to the plant to stand firm in the ground and bear branches and fruits. The lignified cell walls provide mechanical strength to the stem.

d)Investigate, using a suitable stain, the pathway of water in a cut stem:



A leafy twig or a young plants with roots can be placed in red coloured water and few hours.

Observation: the stem, leaves and veins turn to red shows that the waer and dye is transported from roots to leaves.

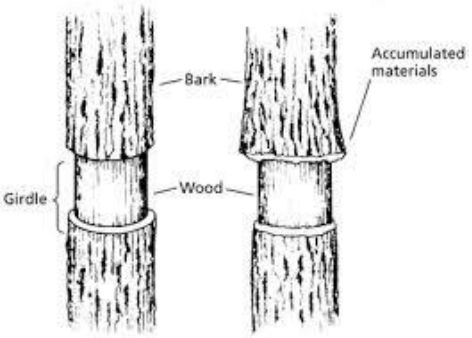
If a section is taken from the stem and observe the xyem vessels uder a microscope, they appear darkly stained.

Phloem vessels transport sugars and amino acids (food) from leaves to the roots and other parts of the plant. The starch stored in leaf is converted sucrose and is transported in solute through the phloem vessels. When it reaches the roots it diffuses into the root and is converted back to starch and stored. This stored starch can be converted to sugars again and is

transported to leaves when needed. During autumn the photosynthesis rate reduces because of lack of light and right temperature. The stored starch is then converted to sucrose and is circulated to the leaves and stem for plant metabolism to occur.

e)Investigating the flow of sugars in phloem: a girdle is made by removing the outer layer of the stem. The phloem situated in the outer ring is removed and the food cannot be transported. But the xylem vessels transport water.

Observation: the area above the girdle swells due to the accumulation of sugars in that region and there is no phloem to transport food down.

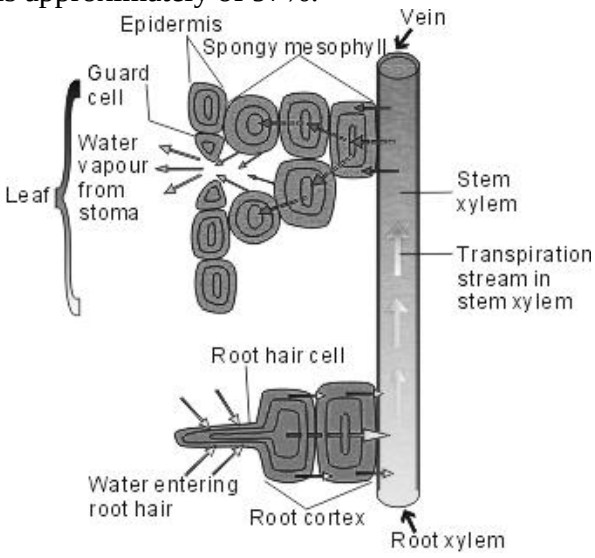


f)State that transpiration is the evaporation of water at the surfaces of the mesophyll cells followed by the loss of water vapour from the leaves through the stomata;

The water absorbed into the root hair cells move to the root cortex by cell to cell osmosis and enters the root xylem. The root xylem is connected to stem xylem and leaf xylem continuously to conduct water and mineral ions to the leaf.

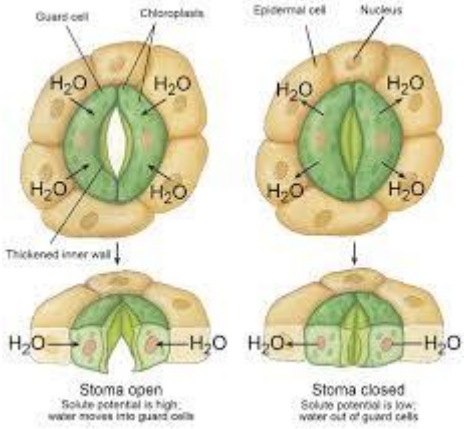
The physical forces that aid the conduction of water in the xylem is; root pressure (osmotic pressure in the root cells), capillarity in the xylem vessels (water molecules stick to the xylem walls and also cohere to each other) and the transpiration pull. Transpiration is the evaporation of water through the aerial parts of the plant.

- Stomatal transpiration: water loss through stomata is approximately of 97%.
- Lenticular transpiration: young tender stems have pores called lenticels, thorough which 2 to 2.4% of water evaporate.
- Cuticular transpiration: about 0.3 to 0.6% of water evaporate through cuticle.



g) explain the movement of water through the stem in terms of transpiration pull:

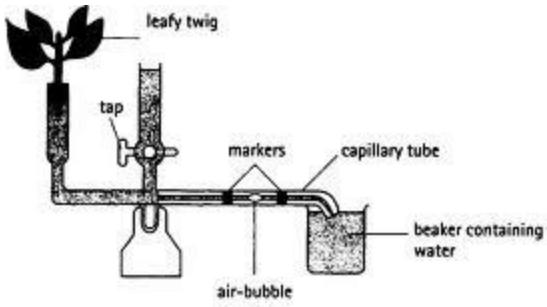
The loss of water from the leaves creates a suction force in the xylem vessels and draw water up. This force is important in the ascent of sap (water and mineral ions) in the xylem and supply water and ions to the leaves that are at the top of the tree.



Mechanism of stomatal opening and closing:

The guard cells control the closing and opening and closing of stomata. When the stomata open plant takes carbon dioxide and photosynthesize. The rate transpiration also will be high. The opening of stomata during day time (more light) is an advantage to the plant to photosynthesize and uptake water by transpiration pull. During the night and times when the water loss is more than the water uptake the guard cells become flaccid and close the stomata. This prevents further loss of water from the leaves.

(h) Describe: • how water vapour loss is related to cell surfaces, air spaces and stomata; rate of transpiration will be high if number of stomata are in large number. Broad leaves have large surface area so that will have more stomata. The upper surface of the leaves of dicotyledons plants usually will have very few or no stomata.



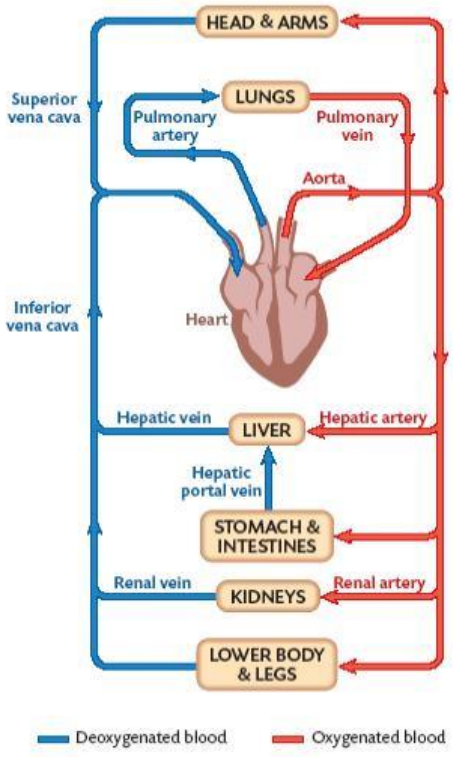
• The effects of air currents (wind), and the variation of temperature, humidity and light intensity on transpiration rate; the instrument shown above called potometer can be used to measure the transpiration rate. The movement of air bubble towards the twig measures the rate of water up take. By this we can assume the water loss. As much transpiration occurs that much water is taken up due to transpiration pull. So water loss is almost equal to water up take.

High temperature causes the water to evaporate quickly, increasing the transpiration rate. Less humidity in the environment provides diffusion gradient and water vapour from air spaces diffuses out down the concentration gradient. High light intensity increases the rate of photosynthesis and stomata are wide open. In this condition also transpiration rate increases.

• how wilting occurs; When the rate of water loss is greater than the uptake the plant loses water and gets flaccid. This makes the plant to wilt. If the plant is provided with water the cells may regain their turgidity and become fresh and normal. When the soil is dry the plants cannot absorb water to compensate the water lost by transpiration. Still plant loses water the leaf cells undergo plasmolysis (permanently flaccid). To avoid this leaf stomata close and prevent further water loss.

7. Transport in Human

(a) Describe the circulatory system as a system of tubes with a pump and valves to ensure one-way flow of blood; circulatory system consists of organs heart and blood vessels. The heart works as a pump to supply blood to the body tissues. The heart has four chambers. The upper two chambers are called atria and the lower two chambers are called ventricles. The atria receive blood from body tissues and pump the blood into the ventricles. There are valves between atria and ventricles. These valves allow the blood flow from atria to ventricles and also prevent the blood flowing back from ventricles to the atria. Ventricles pump blood into the aorta and pulmonary artery. At the origin of these blood vessels there are semilunar valves to prevent blood flowing back to ventricles. These blood vessels carry blood to the body tissues. The deoxygenated blood from tissues is brought back to the heart by veins. The veins have semilunar valves here and there and prevent blood flowing back. This ensures the blood flowing from heart to body tissues and back to the heart in one direction.



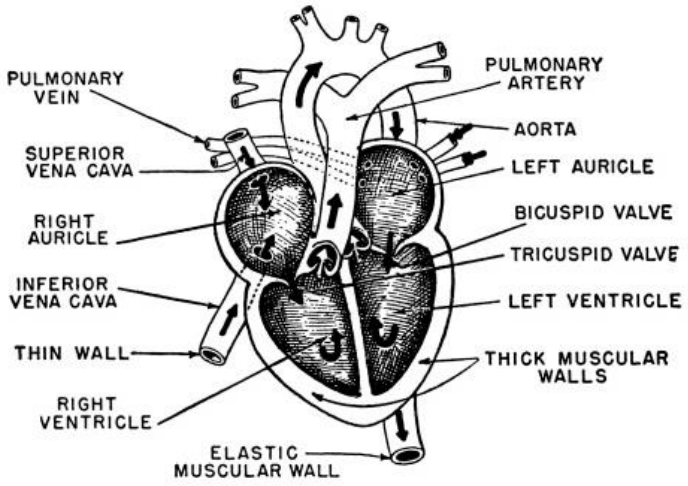
(b) Describe the double circulation in terms of a low pressure circulation to the lungs and a high pressure circulation to the body tissues and relate these differences to the different functions of the two circuits;
Double circulation: blood is pumped through the heart twice in one complete circulation. This is called as double circulation.

- ♥ The deoxygenated blood (blood with carbon dioxide) pumped from heart to lungs to pick up oxygen from the lungs and come back to the heart. This is called pulmonary circulation (between heart and lungs). Since the lungs are situated near to the heart, blood is pumped in low pressure. The right ventricle less muscular than left and so pumps blood in low pressure.
- ♥ The oxygenated blood is pumped at high pressure by the left ventricle of the heart to the body tissues. Since many body tissues are far from the heart, high pressure circulation is needed. The left ventricle have thick muscular wall to pump blood at high pressure. The blood from the body tissues returns back to heart through veins. This is called systemic circulation.(circulation between heart and body tissues)

(c) Name the main blood vessels that carry blood to and from the heart, lungs, liver and kidneys;

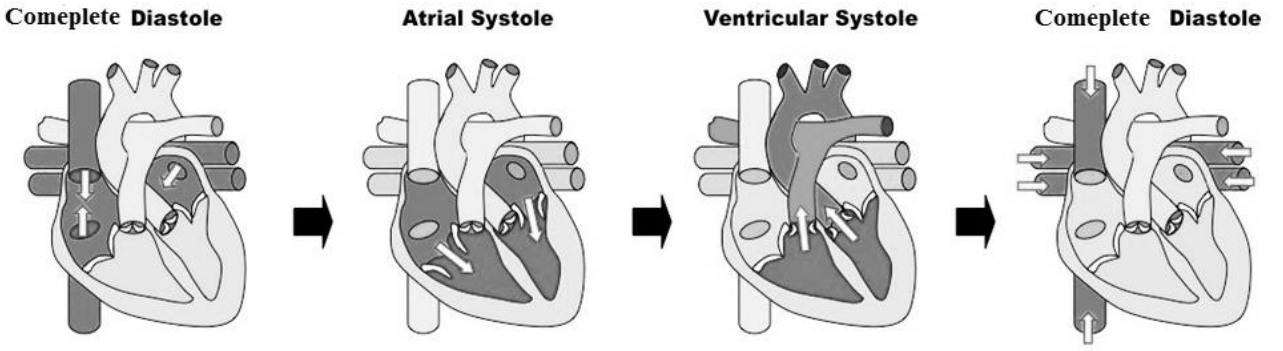
Name of the blood vessel	Composition of blood	Pressure (high or low)/reason
1. Aorta- from heart (left ventricle) to body tissues	Consists of more oxygen, more glucose, amino acids more urea and less carbon dioxide	High as this blood vessels starts from left ventricle and have to carry blood to organs and tissues.
2. Pulmonary artery- from heart (right ventricle) to lungs)	Consists of more carbon dioxide and less oxygen	Lesser pressure than aorta as it starts from right ventricle.
3.Hepatic artery- from heart to liver	More oxygen, glucose, oxygen and less carbon dioxide.	High pressure because it branches from aorta.
4. Coronary artery- from heart (aorta) to heart muscles.	More oxygen, glucose, oxygen and less carbon dioxide	High pressure because it branches from aorta.
5. Renal artery – from heart to kidney.	More oxygen, glucose, amino acids, more urea and less CO_2	High pressure because it branches from aorta.
6.Pulmonary vein- from lungs to heart (left atrium)	More oxygen and less carbon dioxide.	Low pressure because returning from lungs.
7.Hepatic vein- from liver to heart.(into vena cava)	Contain more urea, more carbon dioxide and more nutrients.	Low pressure, as blood returning thorough veins from tissues.
8. Coronary vein – from heart muscle to heart)	Contain more carbon dioxide, less oxygen and less nutrients.	Pressure low.
9. Renal vein (from kidney to heart (vena cava)	Contain more carbon dioxide, less oxygen and less urea	Low pressure, blood flows in veins.
10. Vena cava- from body tissues to heart (right atria)	Contain more carbon dioxide, more urea, more nutrients and less oxygen.	Low pressure, blood flows in veins and returning towards heart.

(d) Describe the structure and function of the heart in terms of muscular contraction and the working of valves;



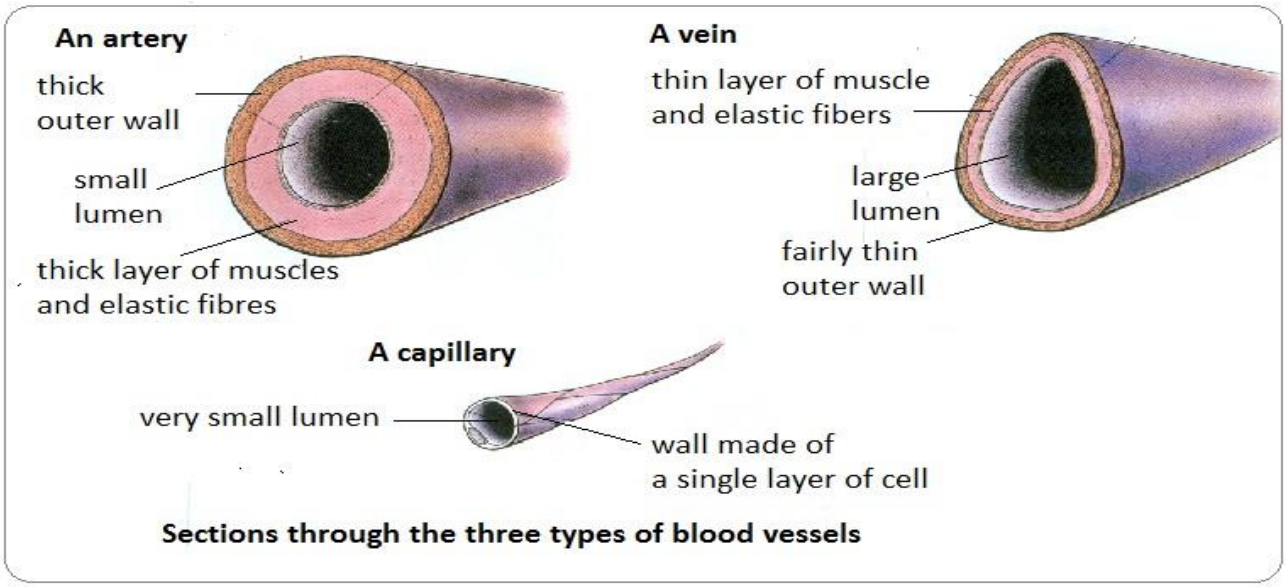
Structure of the human heart.

The heart is made up of cardiac muscles, which can contract and pump blood continuously. The right atrium receive blood from body tissues through vena cava and left atrium receive blood from lungs through pulmonary vein. When the atria are filled with blood they contract and pump the blood into the ventricles. The blood flows from atria to ventricles through tricuspid and bicuspid valves. The walls of ventricles are thicker than the walls of atria as they pump blood away from the heart. The left ventricle wall is much thicker and muscular than right ventricle. Both ventricles when filled with blood contract and pump the blood. The upward pressure of blood closes the tricuspid and bicuspid valves and opens the semilunar valves present at the origin of pulmonary artery and aorta. Blood pumped by the left ventricle into the aorta will be at high pressure as the walls of ventricles are highly muscular. This is important to circulate the blood to the body parts that are far away from the heart through arteries. The blood pumped by the right ventricle into the pulmonary artery is at low pressure as it is carrying blood to the lungs which are closely situated to the heart. The semilunar valves in the start of aorta and pulmonary artery prevent blood flowing back to the ventricles. The following diagram shows the stages in heartbeat and the position of valves. (The rhythmic contraction and relaxation of heart muscles while pumping blood.)



(e)Compare the structure and function of arteries, veins and capillaries;

Function of Artery	Functions of Vein	Functions of capillary
Arteries carry blood away from heart. They contain oxygenated blood except Pulmonary artery	Veins carry deoxygenated blood except Pulmonary vein	Capillaries connect arteries and veins and are large in number to increase the surface area and facilitate exchange of substance between blood and tissues.



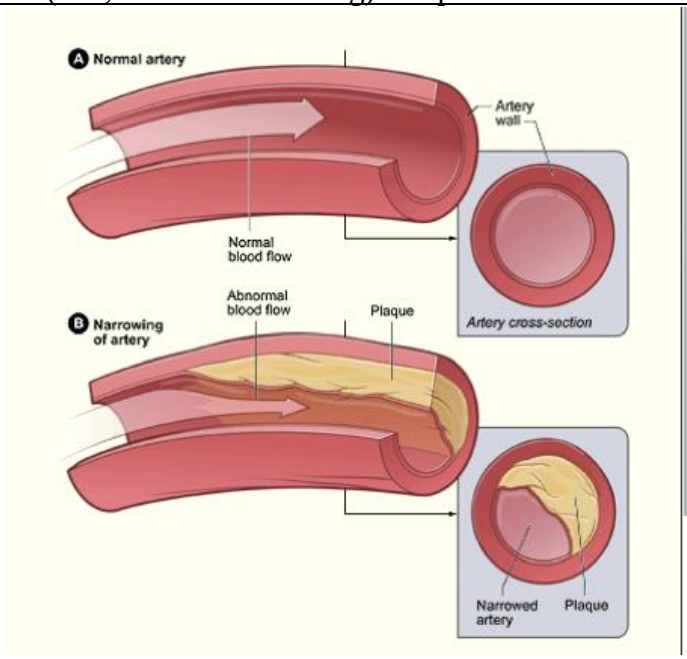
Structural comparison between artery, vein and capillary.

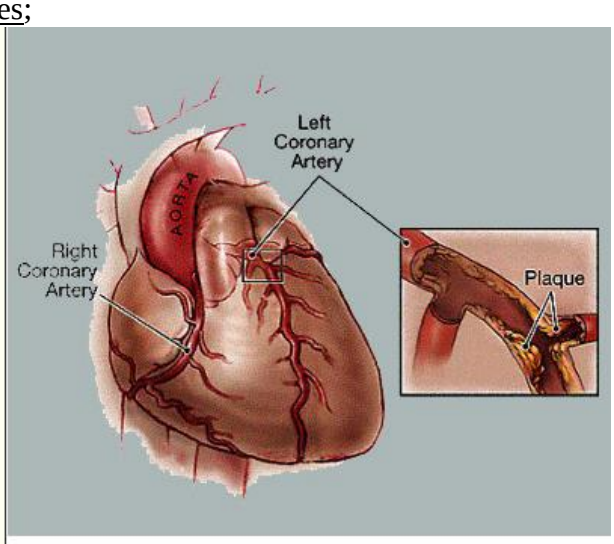
Structure of artery to its function	Structure of vein to its function	Structure of capillary to its function
Made up of three layers	Made up of three layers	Made up of single layer of cells
Outer layer is thick to prevent the vessels from collapsing of high pressure	Outer layer is fairly thin, since veins contain low pressure of blood	No outer layer
Middle layer consists of thick layer of muscles with elastic fibers, so that the artery can stretch when blood enter at high pressure during ventricular contraction and recoil (relax) when the ventricles relax. This prevents the walls getting damage due to fluctuating (changing) pressure.	Middle layer consists of thin layer of muscles with less elastic fibres. Not needed to stretch and recoil as blood flowing in the veins is at low pressure.	No middle layer
Inner wall made up of epithelial cells	Inner layer is made up of epithelial cells	Only consists of single layer of epithelial cells. This single layer allows the diffusion of substance in and out of the capillary through the thin wall.
Lumen is small so that can resist pressure and maintain.	Lumen is large as the flow of blood is at low pressure	Lumen is small
No valves present, so that blood flows without interruption.	Inside veins valves present here and there to prevent back flow of blood and ensure blood returns to heart.	No valves present.

(f) Investigate and state the effect of physical activity on pulse rate; The heartbeat can be measured by placing tips of fingers on radial artery at the wrist or carotid artery at the neck. The pulsative flow (high pressure during ventricular contraction and low pressure during ventricular relaxation) can be used to measure how many times the heart beats in one minute. This is also called pulse rate when we check the pulse at wrist.

A person doing a physical activity such as exercise, or carrying heavy loads needs more energy. The muscles have to respire aerobically to breakdown the glucose and produce energy. So the heart pumping activity increases which means the person's heart beat increases to pump more volume of blood to supply more glucose and oxygen to produce more energy. The pulse rate also increases. When the person rests the heart beat and pulse becomes normal. The heartbeat of a person at rest normally is 70 to 80 times per minute.

(g) describe coronary heart disease in terms of the occlusion of coronary arteries and state the possible causes (diet, stress and smoking) and preventive measures;





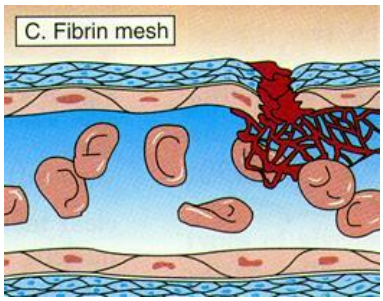
The lumen of arteries may get blocked due to deposition of fat, cholesterol and blood clots on the walls of arteries.

- ♥ Atheroma- the person's diet consists of more saturated animal fats, excess fats and cholesterol remain in blood and get deposit on the walls of artery.
- ♥ Thrombosis- if there is damage to the inner lining of the artery wall, the platelets clots the blood to repair the wall.
- ♥ The fat molecules, cholesterol and blood clots together called as plaque. Due the plaque on the artery wall it bulges and blocks the lumen.
- ♥ When the lumen is blocked blood cannot flow smoothly. To supply a good flow of blood, the heart pumps blood with more pressure. Increased pressure further damages the artery wall and more thrombosis occurs.
- ♥ If the coronary artery gets blocked the heart muscles cannot get blood with oxygen and glucose and cannot contract and pump blood. This results heart attacks and heart diseases.

(h) List the components of blood as red blood cells, white blood cells, platelets and plasma; The blood is a fluid tissue (a tissue is a group of cells) because it has different types of blood cells in liquid plasma. The liquid part of the blood is called plasma and it is made of 70% of water with dissolved substances such as ions, hormones, soluble proteins such as globulin, fibrinogen, urea, carbon dioxide and vitamins.

• Red blood cells (Erythrocytes) – contain haemoglobin and oxygen transport;

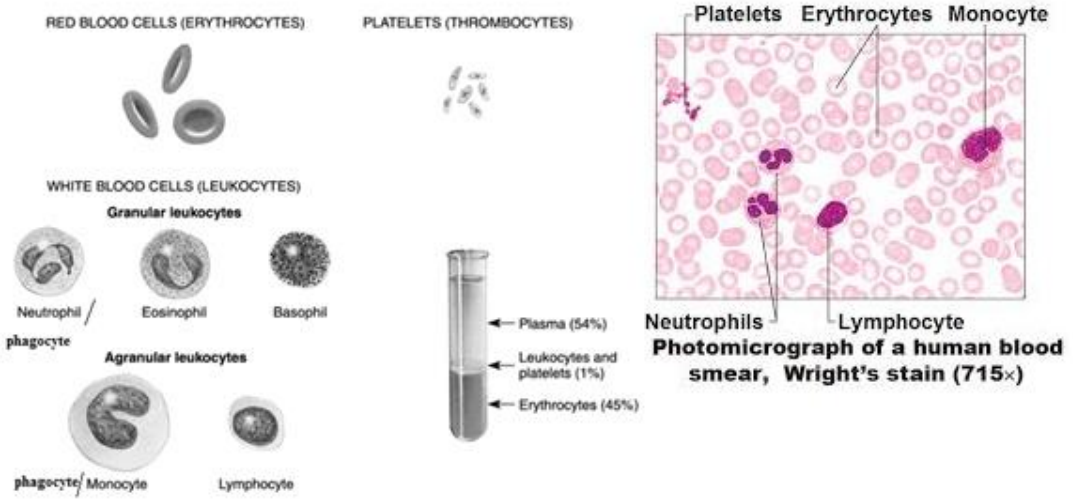
• White blood cells – phagocytosis, antibody formation and tissue rejection; the cells with a nucleus folded into lobes and engulf disease causing bacteria are called phagocytes. The white blood cells that have a round nucleus and secrete chemicals called antibodies are called lymphocytes. The antibodies clump the bacteria together so that phagocytes engulf many at a time.



• Platelets – small fragments of cells, cases blood clotting during injuries. *They release an enzyme thrombokinase and convert a platelet protein pro- thrombin to thrombin. *Thrombin is another enzyme that act of plasma protein, fibrinogen and convert it to fibrin, an insoluble protein. This form a mesh causing clotting; the blood clot seals the wound and prevent the entry of pathogens into the body. The plugged wound prevents the loss of blood.

• Plasma – the liquid part of the blood is called plasma and it transport of blood cells, ions, soluble food substances, hormones, carbon dioxide, urea, vitamins and plasma proteins;

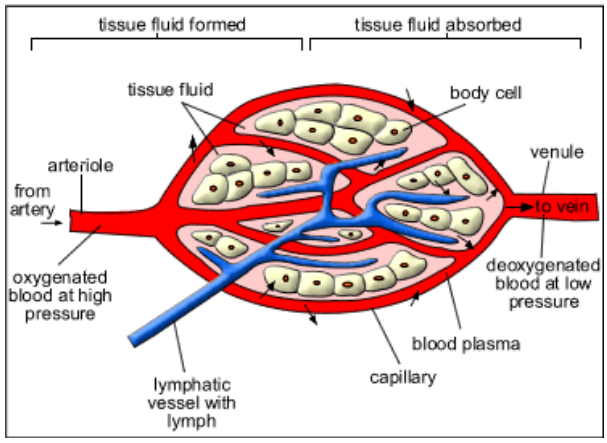
(i) Identify red and white blood cells as seen under the light microscope on prepared slides, and in diagrams and photomicrographs



(j) State the functions of blood:*Blood transports the necessary metabolites to the tissues in solute. the nutrients such as glucose, amino acids and fatty acids are transported to the tissues.

- The water materials such as urea produced in the liver are transported to the excretory organs through blood. Hormones, vitamins, mineral ions are also dissolved in plasma and are transported to the tissues.
- The red blood cells carry oxygen from lungs and transport to the tissues.
- The blood platelets cause blood to clot during injuries.
- The white blood cells of the blood engulf pathogens and protect us from infectious diseases.
- Blood also regulate the body temperature and maintain it uniformly all over the body.

(k) Describe the transfer of materials between capillaries and tissue fluid.



*The blood flowing from arteries is high pressured and when it enters the capillaries, all the small soluble molecules diffuse from capillary wall in between the cells.

* The plasma and dissolved glucose, amino acids, oxygen that leaked in between the tissues forms tissue fluid.

* the nutrients diffuse from tissue fluid to the tissues and waste materials such as carbon dioxide and urea diffuse from tissues to tissue fluid.

* The excess fluid is reabsorbed into the blood capillaries that join to form veins. Some of the tissue fluid is drain into the lymphatic vessels and is called lymph. These lymph vessels carry the lymph and release the fluid into the blood at vena cava.

8. Respiration:

(a) define *respiration* as the release of energy from food substances in all living cells; *(b)* define *aerobic respiration* as the release of a relatively large amount of energy by the breakdown of food substances in the presence of oxygen; *(c)* state the equation (in words or symbols) for aerobic respiration; *(d)* define *anaerobic respiration* as the release of a relatively small amount of energy by the breakdown of food substances in the absence of oxygen; *(e)* state the equation (in words or symbols) for anaerobic respiration in humans and in yeast;

Aerobic respiration	Anaerobic respiration
Glucose is broken down using oxygen to release energy	Glucose is broken down to release energy in the absence of oxygen.
Glucose+ oxygen→carbon dioxide +water+energy $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6CO_2 + 6H\,O$ + energy (36 ATP)	Glucose→ carbon dioxide + ethanol + energy Glucose → lactic acid +energy in human muscles. $C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$ + energy (2ATP) in yeast and anaerobic bacterial
Glucose is completely oxidized to produce large amount of energy.	Glucose is incompletely oxidized and releases very less amount of energy.
The end products are carbon dioxide and water	The end product in human muscle anaerobic respiration is lactic acid. In yeast the end products are ethanol and carbon dioxide
Occurs in all living organisms that respire oxygen	Occurs in organisms when oxygen is not available and in organisms that can respire in the absence of oxygen.

Respiration is a catabolic process (breaking down of large molecules) in which food molecules are broken down into simple molecules and release energy. The carbohydrates such as glucose is the main important respiratory substrate that is used to get oxidize to produce energy. If sufficient amount of glucose is not available fatty acids are used as respiratory substrate and next amino acids as alternative respiratory substrate during starving.

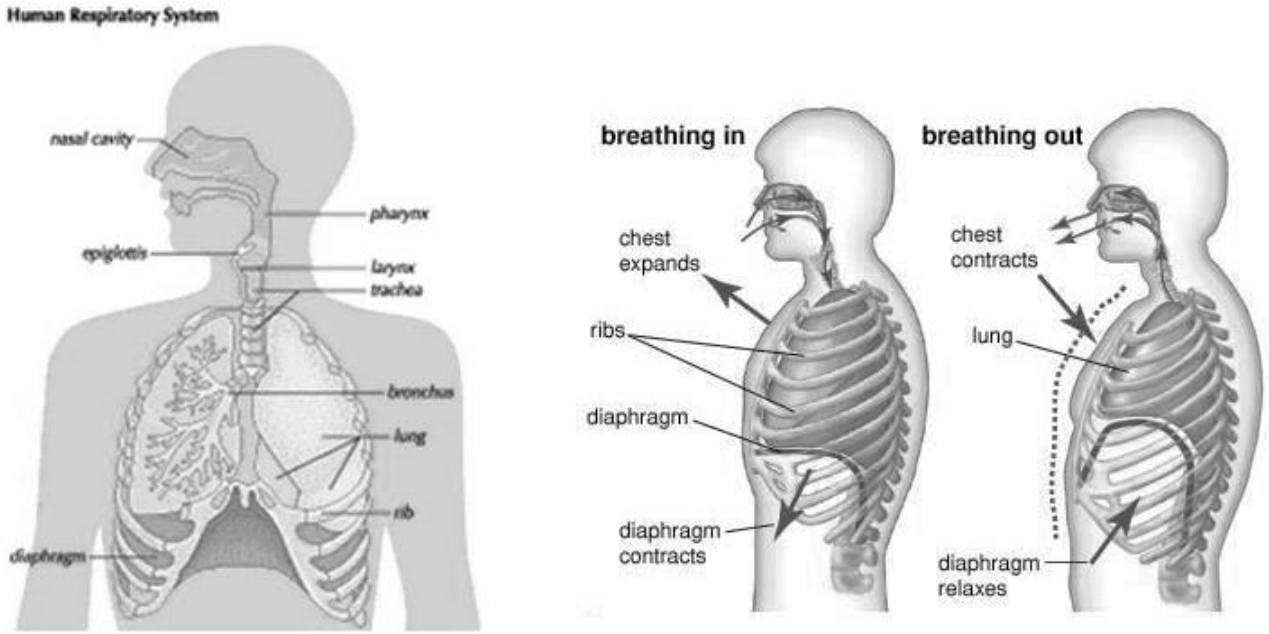
(f) State the uses of energy in the body of humans: muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature;

- Energy released during respiration is carried by ATP chemical molecules and is used for the muscle contraction and helps organisms to move.
- The synthesis of large molecules needs energy. Protein synthesis and growth needs energy.
- The metabolic energy is also used in cell division in producing new cells.
- Active transport of ions in plants, and in human body uses energy.
- The energy is also used in the passage of nerve impulses and also to maintain constant body temperature.

(g) describe the effect of lactic acid production in muscles during exercise.

During physical exercise the oxygen supply to the muscle is not sufficient. The muscles in this condition start to respire anaerobically which release the lactic acid. The lactic acid accumulates in the muscle and also diffuses into the blood. This is toxic and causes the muscle to fatigue. (the muscle tired). The muscle under lo longer contract and cause movement. To avoid this condition the breathing rate increases by the impulses send by medulla oblongata. The increased breathing repays the oxygen debt and aerobic respiration in muscle continues.

(h) identify on diagrams and name the larynx, trachea, bronchi, bronchioles, alveoli and associated Capillaries:



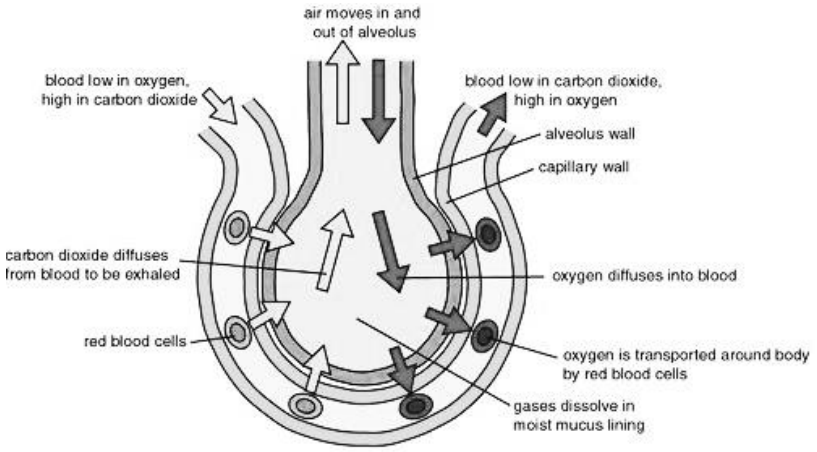
(i) Know the percentages of the gases in atmospheric air and investigate and state the differences between inspired and expired air;

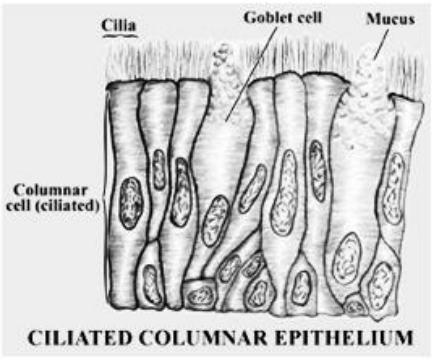
Inspired air	Expired air
Oxygen 21%	16%
Carbon dioxide 0.3%	0.4 %
Nitrogen 78%	78%
Water vapour - traces	Saturated

(j) Describe the role of cilia, diaphragm, ribs and intercostal muscles (external and internal) in breathing

Inspiration (inhaling)	Expiration (exhaling)
External intercostal muscles contract and ribs move up and outward	External intercostal muscles relax and internal intercostals relax. Ribs move down and in.
Diaphragm muscles contract and diaphragm moves down and gets flat	Diaphragm muscles relax and diaphragm moves up to dome shaped
This acts increases the volume of chest (thorax) so that the lungs can inflate.	This act decreases the volume of thorax so that the lungs deflate.
The air pressure inside lungs reduces	The air pressure inside the lungs is increased
The air from outside is drawn in	The air from lungs is forced out.

(j) State the characteristics of, and describe the role of, the exchange surface of the alveoli in gas exchange;





Adaptation of human lungs for efficient gas exchange: The inner wall of the lung is highly folded into the air sacs called alveoli. The numerous alveoli increase the surface area of the lung for efficient diffusion of gases from the blood and lungs. The walls of the alveoli are one cell thick and so decreases the diffusion distance for the gases to diffuse. The alveoli are supplied with blood by a dense network of capillaries. This maintains the concentration gradient of oxygen and carbon dioxide for them to diffuse. The blood capillaries coming to lungs are deoxygenated and have high CO_2 concentration and diffuse into the alveoli. The alveoli receive more oxygenated air and oxygen is highly concentrated to diffuse into the blood capillaries.

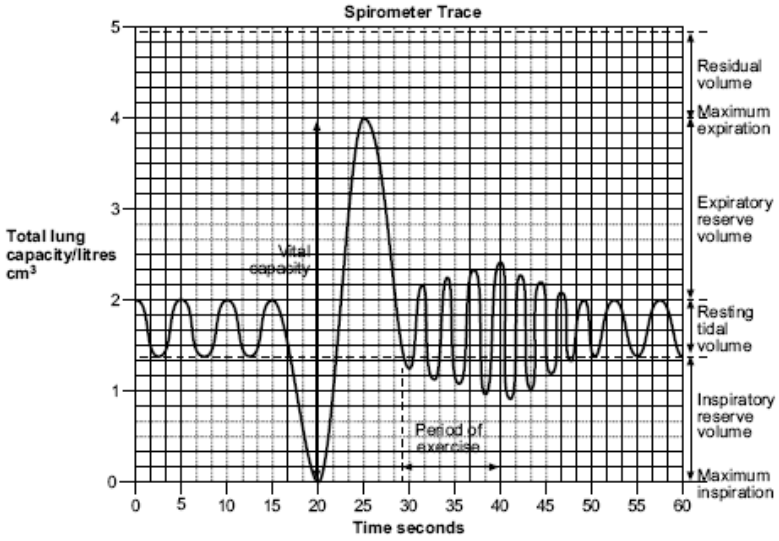
The inner lining of trachea and bronchus are lined with special epithelial cells. This layer consists of cells secrete mucus (goblet cells) which traps the dust and microorganisms from the inhaled air. Some cells have cilia on the surface which move up and down (beating movement) to sweep the mucus with impurities to the back of the pharynx. This ensures that the inhaled air is pure before it enters the lungs so that infections by pathogens and dust are prevented.

(l) Investigate and state the effect of physical activity on rate and depth of breathing;

The breathing rate can be measured by placing index finger below the nostrils or placing hand on the chest and count the rib movement. The inhaling and exhaling can be counted as one breathe and can measure how many times we breathe in one minute.

A person doing a physical activity such as exercise, or carrying heavy loads needs more energy. The muscles have to respire aerobically to breakdown the glucose and produce energy. Since the air we breathe at rest is not enough to meet the demand, there will be an oxygen debt in the muscles. The muscles then start to breathe anaerobically. This will leads to the accumulation of lactic acid in the muscles. As a result the muscle gets fatigue (muscle cramps). To repay the oxygen debt the breathing rate increases. The person's heart beat increases to pump more volume of blood to supply more glucose and oxygen to produce more energy.

When the person rests breathes 13 to 14 times per minute. A spirometer trace can be used to measure the volume of air and breathing rate of a person.



- Between 0 to 15 seconds the person is at rest and breathes 3 times which means 12 times per minute.
- Between 15 to 30 seconds the person breathes deeply and takes in more air.
- Between 30 to 45 seconds the person's breathing rate increased.
- The increased breathing rate repays oxygen debt, allows the aerobic respiration in the muscle, and removes the carbon dioxide and lactic acid from the blood.

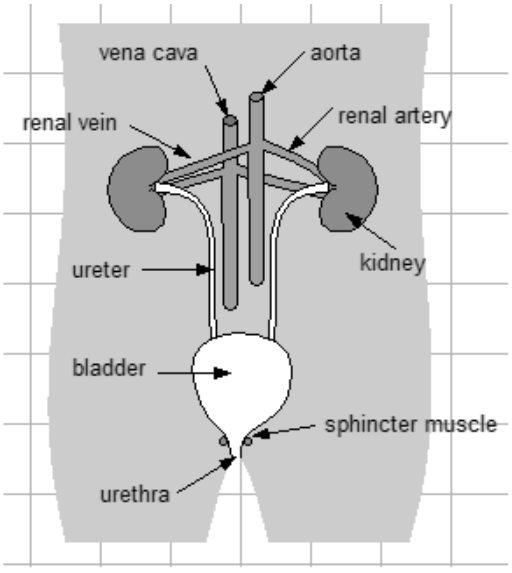
9. Excretion

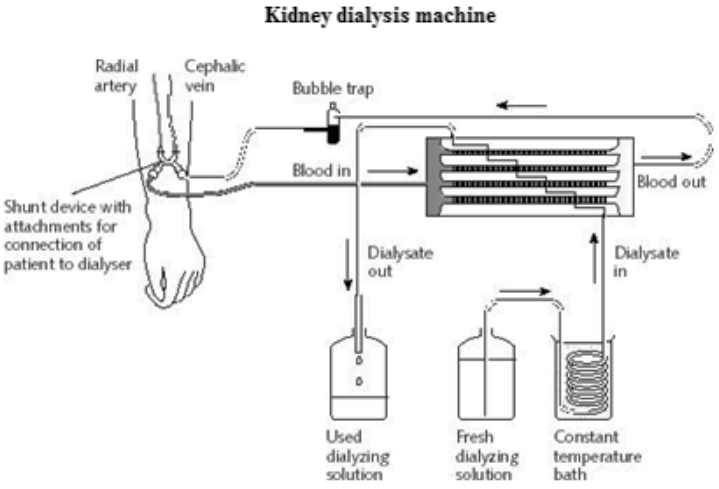
(a) define *excretion* as the removal of toxic materials and the waste products of metabolism from organisms;

Excretion is the removal of metabolic wastes from the body. The waste materials if remains in the blood they become toxic and fatal to the organisms. Example1: urea is produced by the breakdown of amino acids in the liver and is excreted from kidneys. Example 2: sodium chloride from the blood is secreted as sweat by the sweat glands of the skin and eliminated through the sweat pores. Example 3: carbon dioxide produced during respiration is excreted from lungs.

(b) Describe the removal of carbon dioxide from the lungs; during respiration carbon dioxide is produced as a waste product. The carbon dioxide from the tissues is transported to the lungs through the blood. It diffuses from the blood into the alveoli. During the expiration the carbon dioxide is breathed out of the lungs.

(c) identify on diagrams and name the kidneys, ureters, bladder, urethra and state the function of each (the function of the kidney should be described simply as removing urea and excess salts and water from the blood; details of kidney structure and nephron are **not** required);





- There are two **kidneys** in the urinary system of a human being. These kidneys made up of millions of small filtering units called nephrons. The kidney nephrons filter the nitrogenous waste, urea from the blood.
- The urea with water is called as urine, and from the kidneys it passes to a urinary bladder through **ureters**.
- The **urinary bladder** stores the urine temporarily.
- **Urethra** is the structure that releases and excretes urine from the bladder when it is full. The urethra empties the urine from the bladder by the action of sphincter muscles located at the start of urethra.

Ultra filtration of urea: When the blood from renal artery flows at high pressure into the kidney nephrons, all small molecules such as urea, water, glucose, amino acids and salts diffused from blood to the nephrons. This is called as ultrafiltration or high pressured filtration. This mixture is called as glomerular filtration.

Selective reabsorption: The excess water from the filtrate and useful substances from the blood are taken back into the blood from the kidney. This is called selective reabsorption.

Urine secretion: the urea, small amount of salts and water together forms urine and are carried to the bladder through ureters.

(d) Describe dialysis in kidney machines as the diffusion of waste products and salts (small molecules) through a membrane; large molecules (e.g. protein) remain in the blood.

A person, whose two kidneys are damaged, has to undergo dialysis which means the blood of the person to be sent into a machine to filter urea from blood. (refer to the diagram given beside the kidneys)

- The dialysis machine works on principle of diffusion. It acts like a real kidney by filtering the nitrogenous waster from the blood. But it cannot reabsorb the useful substances from the blood.

The blood from the patient's artery or vein is connected to the dialysis tubules present in the machine.

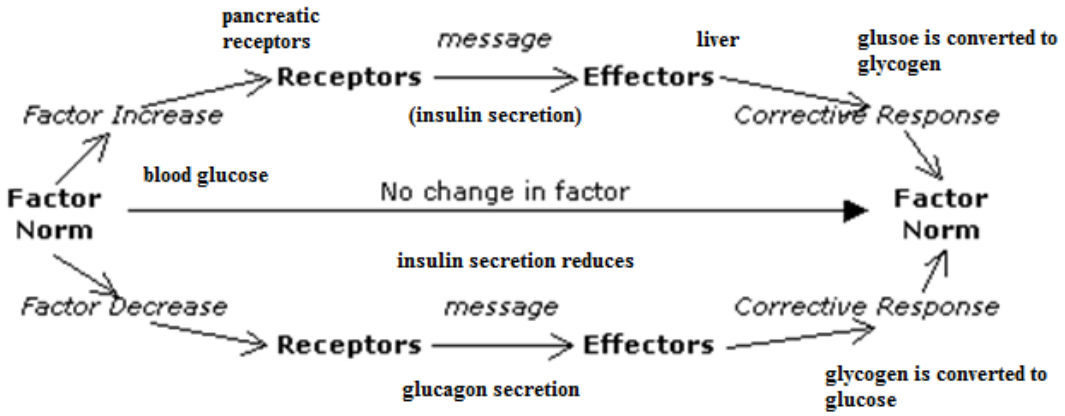
- Inside the machine the space is filled with dialysis fluid which consists of useful substance such as glucose, salts, amino acids and water in the same concentration as in blood, so that they do not diffuse out from the blood.
- The dialysis fluid consists of no urea, so that urea from patient's blood diffuses into the dialysis fluid.
- The dialysis fluid is changed and replaced by new fluid to maintain concentration gradient of urea between blood and fluid.
- The filtered blood returns to the patient's artery or vein, by careful monitoring of the flow, by bubble trapper.

10. Homeostasis

(a) define *homeostasis* as the maintenance of a constant internal environment; the process of maintaining a constant internal environment is called as homeostasis. The internal environment refers to the blood glucose, temperature, salts, water and ions. All these substances should be in right amount in the blood. So their levels to be always kept constant. Negative feedback mechanism occurs in our body for homeostasis.

(b) explain the concept of control by negative feedback; The automatic correction of any internal factor when it deviates from its optimum levels. During negative feedback an increase or decrease of the levels of the factor are brought back to normal.

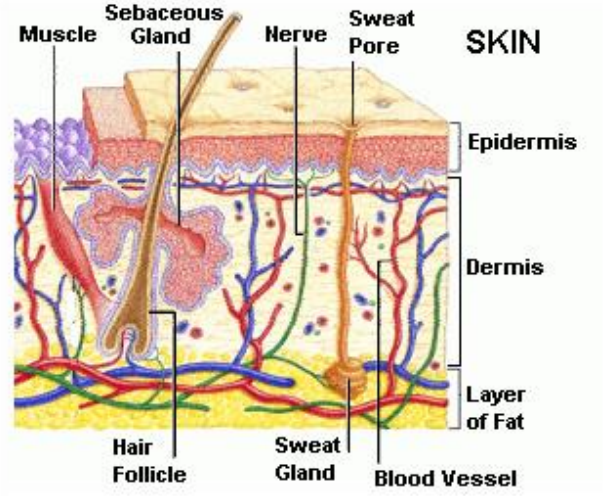
Example: *Glucose regulation by negative feedback:* the blood glucose levels increases the pancreatic cells detect the change and secrete hormone insulin which is transported to liver. The insulin promotes the conversion of excess glucose into glycogen. The blood glucose levels reduce to normal. On the other side if the glucose in blood decreases, the insulin levels fall and another hormone glucagon is produced. This hormone works in liver to convert glycogen to glucose so that the glucose levels in blood rise to normal.

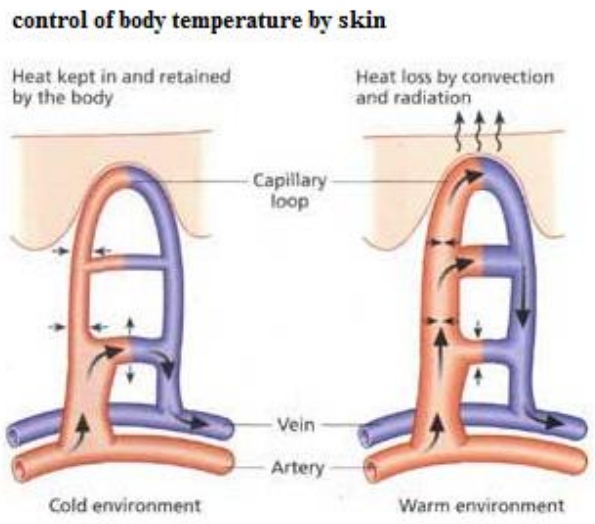


Osmoregulation by kidney: If the water content in blood increases, (winter, cold water bath) the kidneys filter it to form dilute urine and excrete it. The hormone that is used to increase the reabsorption of water from kidneys to blood in inhibited. If water content in blood is less, (playing in hot sun, dry weather, and sunny days) the pituitary gland secretes a hormone called ADH (antidiuretic hormone). This hormone increases the reabsorption of water from urine to blood. Concentrated urine in less volume is secreted and blood water levels are maintained.

(c) Identify, on a diagram of the skin, hairs, sweat glands, temperature receptors, blood vessels and fatty Tissue;

Epidermis -contain three layers, protect from pathogens entry and UV rays, (melanin in the third layer)
Dermis- consists of sweat glands, blood capillaries, arterioles, veins, sebaceous glands, receptors, hair erector muscles and hair follicles.
Sweat gland- filters salt from the blood and secrete sweat and release it out through sweat duct and sweat pores.
Receptors- the nerve endings act as receptors to detect heat, cold, pain and pressure.
Sebaceous glands- secrete oily sebum and lubricate the skin.
hair follicle and hair- hair grows from follicle and the hairs stand erect when the hair erector muscle contract to trap the air in between and insulate the body.
Adipose tissue- below the epidermis, there is a layer of fat (sub cutaneous fat or adipose tissue) that provides insulation and prevents heat loss.





(d) Describe the maintenance of a constant body temperature in humans in terms of insulation and the role of temperature receptors in the skin, sweating, shivering, blood vessels near the skin surface and the coordinating role of the brain:

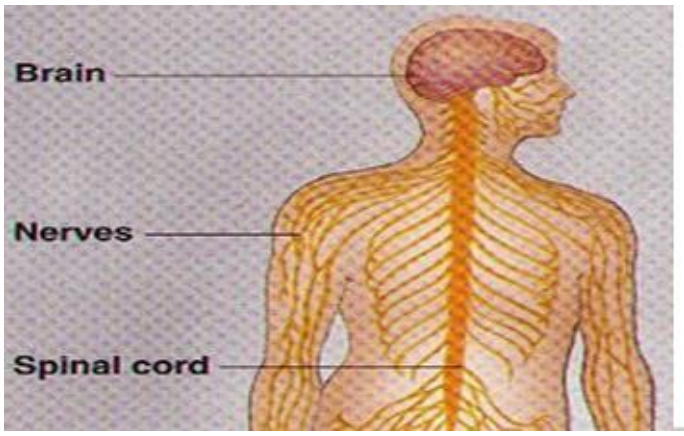
Overheating (body gains heat faster than it loses	Over cooling (body loses heat faster than it gain)
Response-Vasodilation	Response -Vasoconstriction
If the body gains more heat, the heat receptors in skin detect the heat and send the impulse to the brain (hypothalamus) through sensory neurones.	If the body loses heat, the cold receptors detect the stimulus and send the impulse to the brain (hypothalamus) through sensory neurones.
The brain sends impulse to the skin arterioles through motor neurones.	The brain sends impulses to the skin arterioles through motor neurones.
The skin arterioles dilate (widen), and send more warm blood to the surface of the skin,	The skin arterioles constrict (narrow) and send less blood to the surface of the skin.
Heat is lost by conduction and radiation	Heat loss is prevented, heat is retained.
Sweat glands secrete more sweat and evaporation cools the body.	Less secreted, hair erector muscle contract, and causes hair erection. Air is trapped between the hairs and insulated the body.

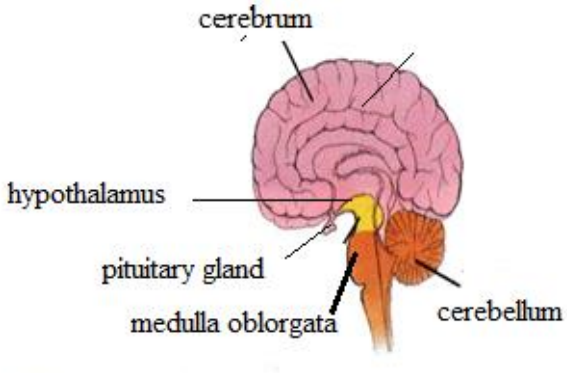
11. Coordination and response

(a) State that the nervous system – brain, spinal cord and nerves, serves to coordinate and regulate bodily functions; The coordinated behavior works in the following five components. Stimulus is any change in external or internal environment. Eg. Loud sound. The sound is now detected by the receptors of ear; pass the impulse to the brain (coordinator) through sensory neurones. The relay neurones in the brain process and pass the impulse to the effectors (glands or muscles) through the motor neurones. The person close the ears using hands is the response.

stimulus ⇨ receptors ⇨ coordinator ⇨ effectors ⇨ response

(b) Identify, on diagrams of the central nervous system, the cerebrum, cerebellum, pituitary gland and hypothalamus, medulla, spinal cord and nerves;





(c) Describe the principal functions of the above structures in terms of coordinating and regulating bodily functions;

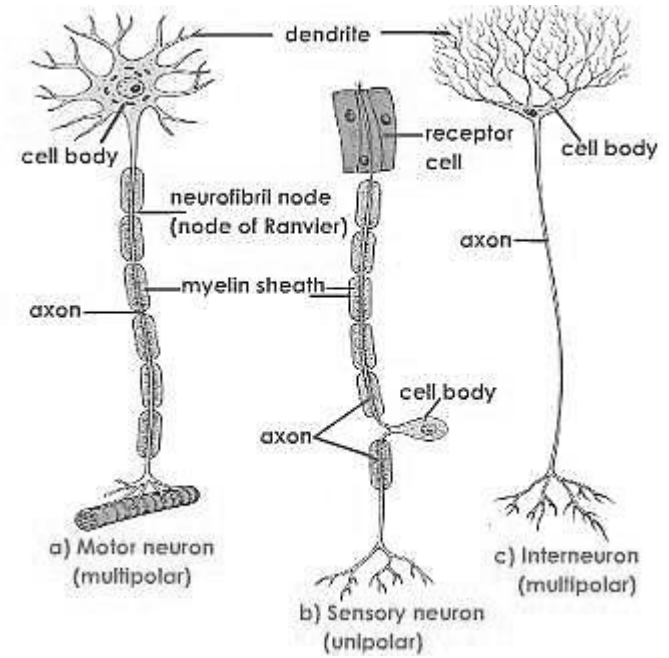
Structure of brain	Function
Cerebrum	The cerebral hemispheres control the conscious activities and are responsible for memory, thinking, reasoning, decision making and other sensory information processing and coordinate response to stimulus.
Cerebellum	Controls the muscular coordination, balance and posture.
Hypothalamus	Controls the homeostasis, which means the temperature control and osmoregulation.
Medulla oblongata	Controls the involuntary action such as heart beat and breathing rate.
Pituitary gland	This is an endocrine gland located just below the hypothalamus and secretes growth hormones and many other hormones that control the activities of other endocrine glands.
Spinal cord	Spinal cord continues from medulla, allows the spinal nerves to pass to and from the organs. It also acts as coordinator in generating reflex responses.

(d) Outline the functions of sensory neurones, relay neurones and motor neurones;

Sensory neurones- End in the receptor cells to detect stimuli. They carry impulses from receptors to central nervous system. Their cells bodies are small, with axon and long dendrites.

Relay neurones- connect the sensory neuron with motor neuron and present in the central nervous system. (Brain and spinal cord).

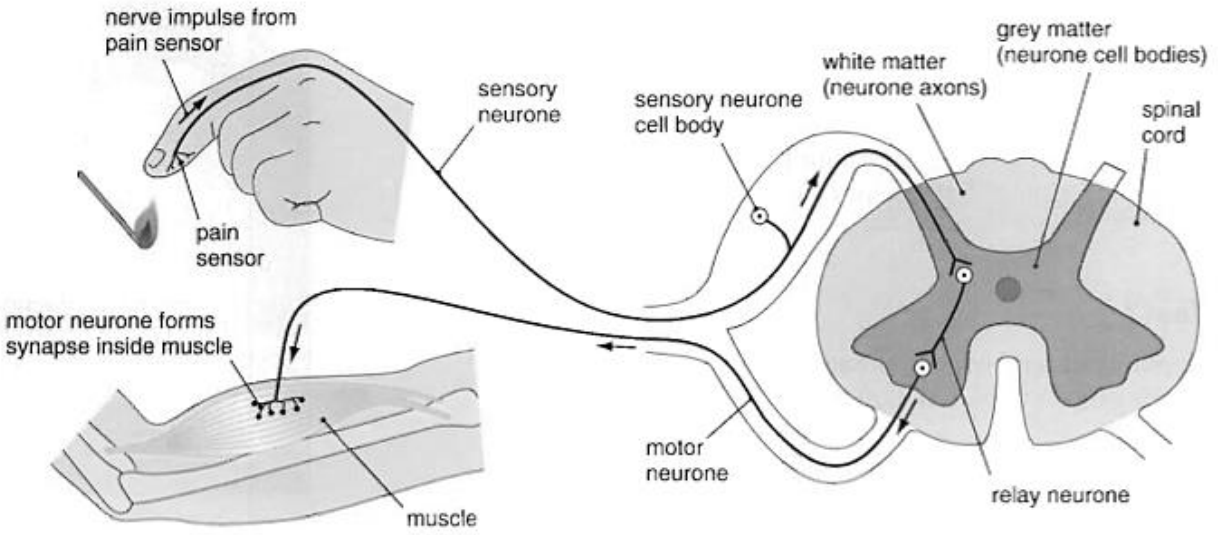
Motor neurones- have large cell body, long axon and short dendrites. They carry impulses from central nervous system to effectors. (glands and muscles).



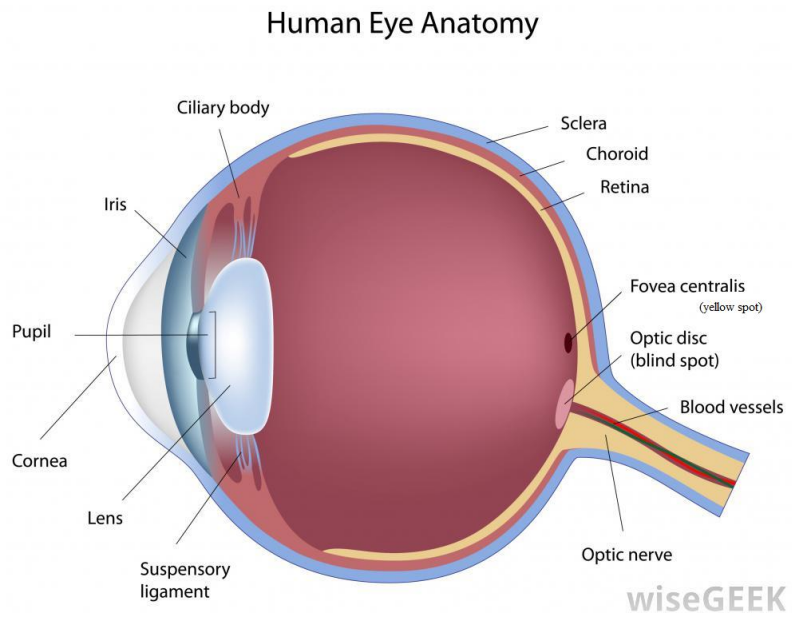
e) Discuss the function of the brain and spinal cord in producing a coordinated response as a result of a specific stimulus (reflex action);

Reflex actions are sudden and rapid response for a stimulus. If a stimulus is dangerous the nervous system has to make quick response to prevent any damage due to the stimulus to the body. Hence these reflex responses are useful in protecting the body organs from dangerous stimulus. During the reflex actions the impulses of sensory neurones are processed either in the spinal cord or brain and take a short route to send impulses through motor neurones to the effectors for immediate response. Example : touching a hot object immediately withdraw the hand.

The reflex arc is the path of way of neurones of a reflex action. The receptors detect the hotness, and the sensory neuron carries the impulse to the spinal cord. The relay neuron in the grey matter processes the impulse and passes the impulse to the motor neuron. The motor neuron carries the impulse to the hand muscle (biceps) which contract and causes the hand to move away from the flame.

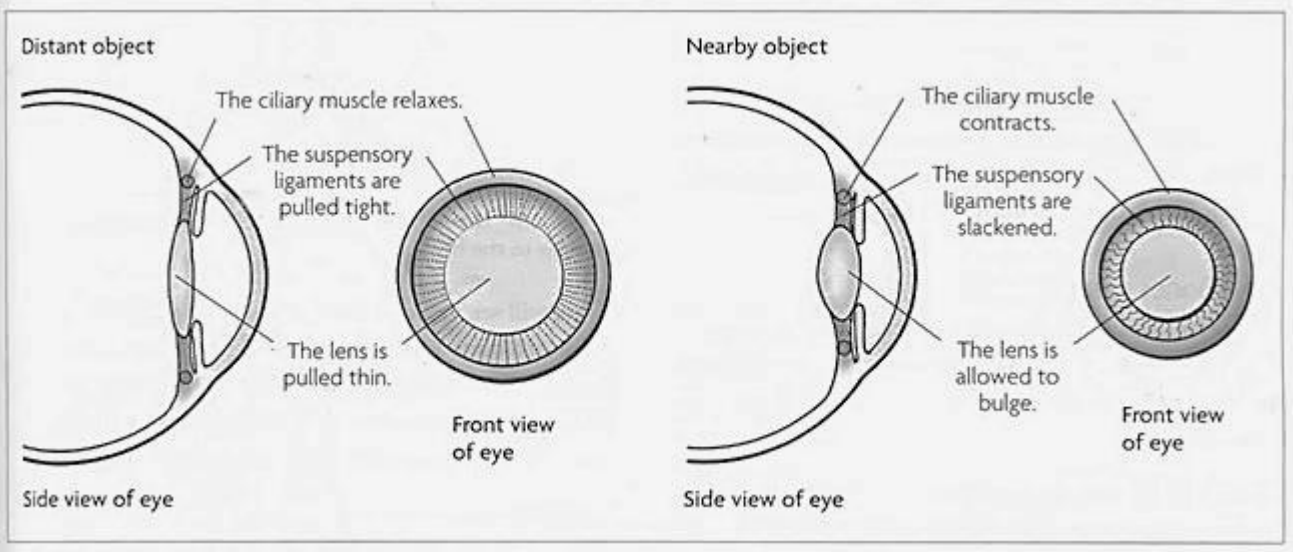


(f) Describe the gross structure of the eye as seen in front view and in horizontal section;



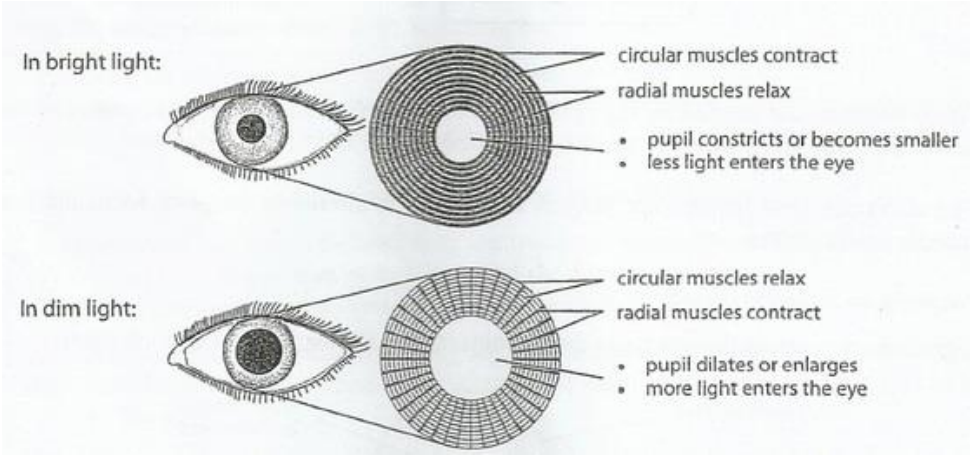
Sclera- the outer most layer of eye ball and protect it and maintain the shape of the eye ball.
Choroid- the middle layer of the eye, which has pigment to prevent the internal reflection. It's also supplied with blood vessels to nourish the eye structures.
Retina – inner most layer and consists of rod cells and cones for detecting the light and form image of the object.
Fovea- (yellow spot) area on the retina where image is formed and colour vision is accurate.
Blind spot- the area on retina where optic nerve starts and no image is formed. The part of the image not covered by the blind spot of one eye is compensated by the other eye. In binocular vision two eyes carry two images to the brain, and both are put together to make a complete image for us to get the three dimensional complete view of the object.
Conjunctiva- thin transparent layer over cornea that protect eye.
Cornea- the curved bulge in front of the eye, transparent and allow light to enter the eye.
Iris- the coloured muscle (black/ brown/blue) determines the eye colour and also controls the size of pupil.
Pupil: The opening between the iris which allows the light to enter the eye. The diameter of the pupil gets small in bright light and big in dim light and adjust the amount of light entering the eye.
Lens- transparent crystalline structure that refract light rays from the object and focus it on retina.
Ciliary body- consists of antagonistic muscles (one muscle contract another relax) that can alter the shape of the lens for near and far vision.
Suspensory ligaments- structures that hold the lens and pull or release it to change its shape.
Aqueous humor- the fluid in front of the lens and provide nutrients to the transparent parts of eye.
Vitrious humor- the fluid inside the eye ball back of the lens, maintain the shape of the eye ball and provide nutrients to the transparent part of the eye.
(g) State the principal functions of component parts of the eye in producing a focused image of near and distant objects on the retina;

Far vision accommodation	Near vision accommodation
Radial ciliary muscles contract and circular ciliary muscles contract	Circular ciliary muscles contract and radial ciliary muscles relax
Suspensory ligaments taut (more tension)	Suspensory ligaments slacken (losen)
Lens is stretched to refract the parallel light rays to enter and refract through the lens	Lens become round to increase the curvature to refract the diverging rays come from near object
Pupil widen	Pupil narrows



(h) Describe the pupil reflex in response to bright and dim light;

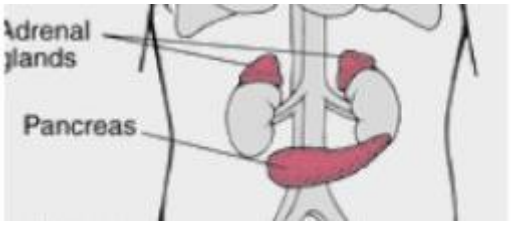
The changing size of pupil is important in controlling the amount of light entering the eye. The iris antagonistic muscles cause the changes in pupil size. Refer to the figure beside to understand the action of iris muscles in altering the pupil size.



(i) define a *hormone* as a chemical substance, produced by a gland, carried by the blood, which alters the activity of one or more specific target organs and is then destroyed by the liver;

Hormones are chemical molecules secreted by endocrine glands. The endocrine glands are ductless and release the hormones directly into the blood. Hormones change the chemical reactions either by speeding up or slowing down to make correct response to a stimulus. Hormones are small molecules so easily diffuse into the blood and work efficiently in smaller concentrations. They are carried to the target organs (the organs that effected by the hormone) by blood stream and after they are used up destroyed by liver.

(j) State the role of the hormone adrenaline in boosting the blood glucose concentration and give examples of situations in which this may occur;



Adrenal glands are located over the kidneys and secrete hormone adrenaline. Adrenaline is transported to the target organs liver, heart and lungs. In the liver glycogen is converted to glucose to supply extra glucose for respiration.

The breathing rate increases to take in more oxygen for respiration. Heart rate increases to supply the oxygen and glucose to the muscles. The overall effect of the hormone is to increase the rate of respiration and produce more energy to cope with situation. This hormone is released when a person is angry, frightened, and anxious or stressed. It's the organ of fright and flight.

(k) Describe the signs (increased blood glucose concentration and glucose in urine) and treatment (administration of insulin) of diabetes mellitus.

After a heavy carbohydrate meal, the glucose concentration in blood increases as the carbohydrates are digested and absorbed into the blood. The increased levels of glucose are detected by pancreas and it secretes insulin. The insulin promotes the conversion of glucose to glycogen in the liver and brings the glucose concentration to normal. The insufficient secretion of insulin inhibits the conversion of glucose to glycogen. As a result glucose concentration in blood increases. In the kidneys the glucose filtered from blood cannot be reabsorbed back and glucose is lost in the urine. This condition is called diabetes mellitus.

Symptoms and treatment of diabetes: high blood sugar; presence of glucose in the urine; extreme tiredness; weight loss and severe thirst. Increased glucose in the blood reduces the water potential of blood and draw water from the tissues. The volume of blood increase and the person urinates frequently. To replace the water lost by the tissues, thirst increases. To treat the disease doctors prescribe drugs that control the blood glucose and in case of very high levels of glucose in the blood, insulin hormone can be taken by injection. The people with diabetes should carefully monitor their diet by reducing carbohydrate rich nutrients in their diet.

12. Support, movement and locomotion

(a) Identify and describe, from diagrams, photographs and real specimens, the main bones of the forelimb (humerus, radius, ulna and scapula) of a mammal;*(b)* describe the type of movement permitted by the ball and socket joint and the hinge joint of the forelimb

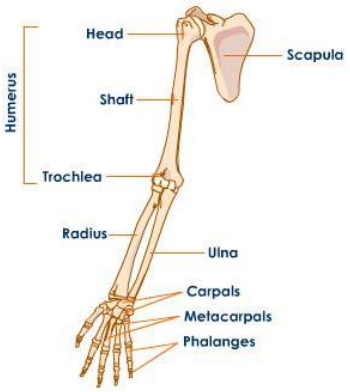


fig1. bones in arm

fig2. hinge joint (one plane movement)

fig3. ball and socket joint (three plane movement /arm rotation)

Bones give shape and support to the body and maintain posture. The skeletal system is made of bone and muscles. The bones and joints cause movement and locomotion. The shoulder bone is called as scapula and forms a ball and socket joint with the head of the humerus. The ball and socket joint allow the arm to rotate and move in three planes. The lower part of the humerus makes a hinge joint with two lower arm bones radius and ulna. The hinge joint provides one plane movement (fold the arm and straighten).

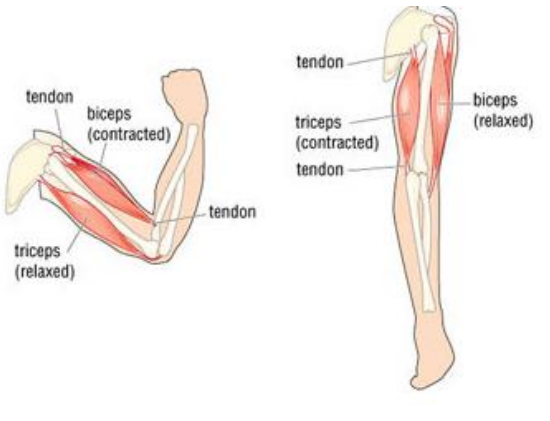
*(*c) Describe the action of the antagonistic muscles at the hinge joint.
Muscles that occur in pairs and work in opposite direction are called antagonistic muscles. When one muscle contracts another muscle relax. This is called antagonistic action. Eg. Muscles in iris, muscles in ciliary body, muscles in oeosphagus and flexor (biceps) extensors (triceps) of arm.

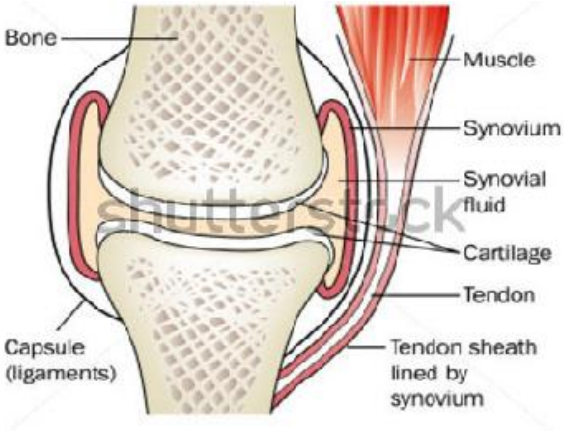
Flexion of arm (folding at hinge)	Extension of arm (straighten)
The bicep muscles contract and pull the radius and ulna towards humerus. During this time triceps muscles relax. As a result arm is folded.	The triceps muscles contract and pull the radius and ulna away from humerus. During this time the bicep muscles relax. As a result the arm is extended (straighten)

Ball and socket joint and hinge joints are called synovial joints. These joints are protected by synovial capsule that secretes synovial fluid. The synovial fluid lubricates joint and provide friction free movement.

Ligaments: ligaments are the structures that join bone to bone at a joint. They hold the bones in position firmly and are slightly elastic to make the movement free and without friction.

Tendons: these are the structures that connect muscles to bone. Tendons are non-elastic so that without stretching by itself allow the muscle to contract with less force and cause movement in bones.





13. The use and abuse of drugs

:

(a) define a *drug* as any externally administered substance that modifies or affects chemical reactions in the body;

Drugs are externally administered chemical substances that modify or effects of chemical reactions in the body. Most drugs are prescribed by the doctors for providing relief from diseases.

Antibiotics	Stimulants	Depressants	addictive
Chemicals usually secreted by microorganisms such as bacteria and fungi. Used to treat bacterial infections. Eg. Penicillin, ampicillin	Chemicals that increase the speed of nerve impulses. Eg; nicotine in cigarette smoke, caffeine in coffee.	Chemicals that slow down the nerve impulses and makes people inactive. Eg; alcohol, heroin, opium	Drugs that make people feel to use again and again. Eg alcohol, heroin, opium

(b) Describe the medicinal use of antibiotics for the treatment of bacterial infection;

- Antibiotics are used to treat infectious diseases caused by bacteria. These chemicals kill the bacteria that entered the body and control their growth. Antibiotics that kill bacteria are called bactericidal and that reduce the growth and reproduction of bacteria inside are called bacteriostatic. The amount of antibiotic concentration that kills the microorganisms effectively is called the right dose of drug.
- Doctors prescribe a course of antibiotics to control the bacteria completely. If a person not using the complete course some bacteria remain alive. These bacteria might have special variation to survive unaffected by the drug. They become resistant to the antibiotic and multiply, increase their number. When next time, the taking of the antibiotic cannot kill the resistant bacteria. Though bacterial diseases such as syphilis can be cured well, survival of antibiotic resistant bacteria may be a disadvantage of antibiotics.

(c) Describe the effects of the abuse of heroin: powerful depressant, problems of addiction, severe withdrawal symptoms and associated problems such as crime and infection e.g. AIDS;

Any drug taken without doctor's advice, used without control and in excessive amounts is said to be abuse of drug.

- Heroin is a depressant drug. This drug slows down the nerve impulses and gives a feeling of unknown pleasure (euphoria). Causes addiction and makes people withdraw from social responsibilities. The normal function of nervous system damages and eventually harms the person
- . If the person wants to stop the use of the drug, he or she will experience severe withdrawal symptoms (pains, muscle cramps, dryness of mouth).
- The drug addicts develop criminal attitude to obtain the drug and use it. Sometimes any member in group of people infected with AIDS, and they using same syringe to inject the drug, may spread the AIDS.

(d) describe the effects of excessive consumption of alcohol: reduced self-control, depressant, effect on reaction times, damage to liver and social implications;

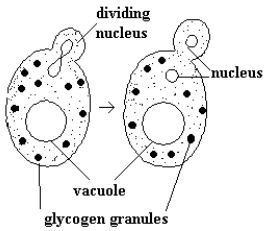
Short time effects of alcohol- depression in visual center of brain make the vision blurred, depression in cerebellum makes the alcoholic to stagger, reaction time increases means reflex actions slowdown, irritation in stomach and loss of appetite follows. As overall effect the person loses self- control.
Long term effects: alcohol is harmful to the body systems and so the liver cells detoxify it and make it harmless. However prolonged use of alcohol damages the liver cells and causes liver cirrhosis.
Social implications: alcoholic addicts spend lot of money on buying alcohol and neglect their families. In depression and out of self-control state they may attempt crimes. The unbalanced state keeps them and their in awkward position. Driving by alcoholic people may lead to increased road accidents.

(e) Describe the effects of tobacco smoke and its major toxic components (nicotine, tar and carbon monoxide) on health: strong association with bronchitis, emphysema, lung cancer and heart disease, and the association between smoking during pregnancy and reduced birth weight of the baby;
Nicotine- it is a stimulant drug, increase the speed of nerve impulses and damage the nervous system. Nicotine in blood increases the pressure and damages the arteries. This eventually leads to the deposition of fats and cholesterol on the walls arteries and heart diseases.

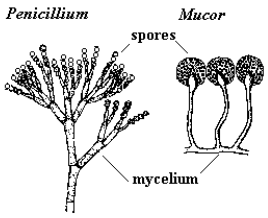
Carbon monoxide: carbon monoxide combines with haemoglobin irreversibly and haemoglobin is not available for oxygen to bind. The oxygen supply to the tissues reduced and person feels shortness of breath and other respiratory disorders.
Tar: smoke consists of tar, which can deposit on the alveolar walls. Alveolar walls lose their elasticity and the surface area for gas exchange decreases. This destruction of alveolar walls reduces oxygen intake and causes shortness of breath. This condition is called emphysema. Cigarette smoke also consists of many carcinogens (cancer causing chemicals) which can cause lung cancer.
All the chemicals in the smoke increase the secretion of mucus. Increased mucus production remains in the trachea and arrest the movement of cilia. The microorganisms in air remain in mucus and causes infection. The walls of trachea, bronchi damage and cause bronchitis.
If pregnant women smoke the oxygen supply to the baby in the womb decreases and the baby at birth would have less weight.
(f) Recognize the fact that many people regard smoking as no longer socially acceptable. Smoking not only causes many respiratory and circulatory diseases to the smoker but also to the one who is around the smoker. The passive smokers also get affected by cigarette smoking. Smoking causes unpleasant odor (smell) and causes inconvenience to the people stays in the circle of smoker. It is a waste expenditure of money too.

14. Microorganisms and biotechnology

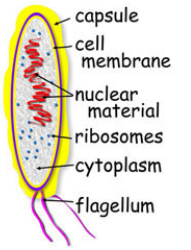
(a) List the main characteristics of the following groups: viruses, bacteria and fungi;



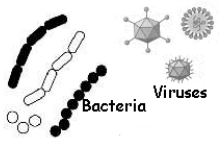
fungi (unicellular) yeast



mould fungi (mycelium) multicellular



Bacterial cell with naked DNA



shapes of bacteria and viruses

Bacteria	Virus	fungi
Unicellular microscopic organisms measuring a few micro meters.	No cellular structure and measure about 20 to 400 nanometers	Occurs are unicellular(yeast) and multicellular forms(mushrooms and moulds)
Have a circular DNA floating in the cytoplasm. Not enclosed in nucleus.	Some virus contains DNA and some may have RNA. No nucleus.	Contain nucleus with genetic material DNA inside.
Cell walls made up of proteins and carbohydrates is present.	No cell wall or any other organelles. Only a protein coat is around the genetic material.	Cells walls are made up of chitin.
Respire aerobic with anaerobic methods.	Do not perform any life activities but reproduce in host cells.	Respire aerobically anaerobically
Some bacteria feed autotrophic, some live as saprophytes or parasites.	All viruses are parasites.	No chlorophyll, feed on dead and decay organic matter by external digestion.
Reproduce by asexual methods such ad binary fission	Reproduce by duplicating the genetic material.	Reproduce by asexual methods such as budding in yeast, and spore formation.

(b) Outline the role of microorganisms in decomposition;

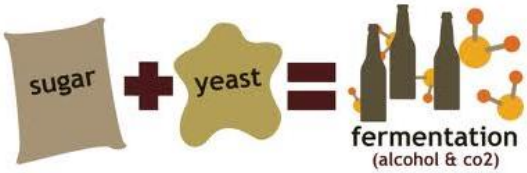
Saprophytic bacteria and fungi feed on dead and decaying organisms. While feeding they secrete enzymes on the food and breakdown the food into simple compounds and absorb the digested end products. They absorb very little amounts and release the rest into the environment and recycle the chemicals such as carbon dioxide and nitrates.

Example- the bacteria feeding on dead organic matter, breakdown the carbohydrates and use them for respiration. During this process they release carbon dioxide into the atmosphere. They breakdown the nitrogen compounds in dead and excretory materials into ammonia. This is called decomposition. They further convert them into nitrates which enrich the soil with nitrates. Some of the simple nitrogen compounds they use for their growth.

(c) Explain the role of yeast in the production of bread and alcohol;

yogurt making


Bread making (kneading)



brewing of beer (barley malt + yeast)

(d) Outline the role of bacteria in yoghurt and cheese production;

Yoghurt production: a rod shaped bacteria called lactobacillus. *milk is heated to boil so that other bacteria in milk can be killed. * Then cooled to 40 to 45^{o} C to provide right temperature to the bacteria to respire and multiply. * Lactobacillus bacteria is added (a starter culture also called inoculum). * the milk with bacteria is allowed to incubate for 6 to 10 hours. * During the period of incubation the bacteria convert milk sugar lactose to lactic acid while respiring anaerobic way. * The lactic acid ferment the milk, curdle (solidify) and gives characteristic flavor to the yoghurt. * While setting the yoghurt fruits and other flavors may added.

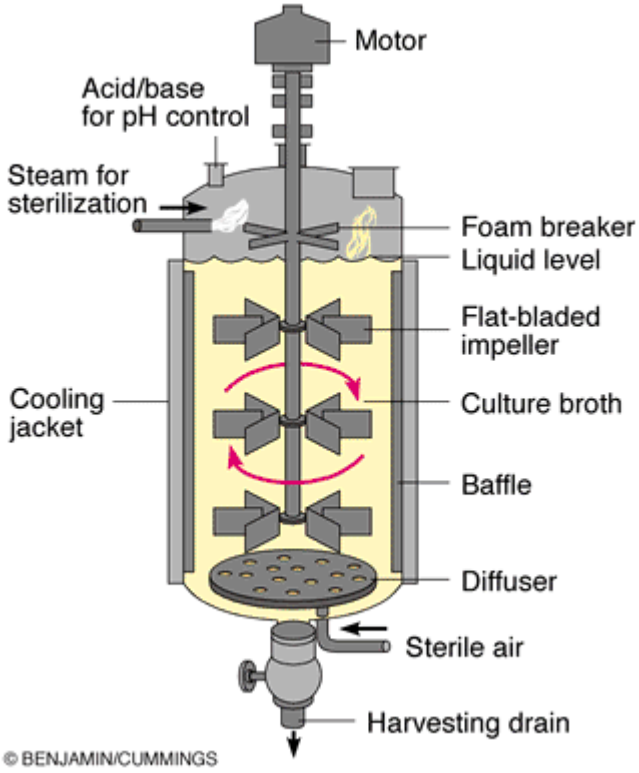
Cheese production: same process of yoghurt making is followed; the liquid part of the yoghurt is called whey and is removed to get thick cheese. The solid cheese part is pressed into different shapes such as blocks or layers and packed.

(e) Describe the use of fermenters for large-scale production of antibiotics and single cell protein;

(f) Describe the role of the fungus *Penicillium* in the production of penicillin.

Antibiotic production (penicillin)	single cell protein production (mycoprotein)
Moulds fungus Penicillium is added to the culture solution in the fermenter	Filamentous fungus Fusarium is added to the culture solution in the fermenter.
Penicillium and nutrients such as glucose, amino acids added to the fermenter all at a time.	Fungus and nutrients can be added continuously to replace the nutrients used up by the fungus.
The Penicillium uses the nutrients, respire aerobically and reproduce to grow. When the nutrients are used up the fungus produce antibiotics to kill other fungus to avoid competition.	The growth of fungus produces protein in their cells. This protein is extracted continuously form the fermenter.

Use of fermenters in the production of antibiotic and single cell protein:



- Fermenters are large container made of special durable steel material which can withstand conditions such as temperature, pH and pressure.
- Nutrient broth consists of a carbohydrate source, protein source and growth factors is added to the fermenter and steam is sent into the fermenter to sterilize the nutrients (remove any unwanted microbes).
- The desired fungal species is added.
- The fungi use the carbohydrates and produce energy and protein source for growth and metabolism.
- The sterile air pipe with sparger (diffuser) supply air with oxygen evenly in the broth for the aerobic respiration of the fungi.
- The motor with impeller mixes the culture broth so that nutrients and air are distributed evenly in the fermenter.
- The cooling jacket around the fermenter is circulated with cool water. This cool water absorbs the heat generated by fungal respiration and regulates the temperature to optimum.
- The exhaust removes the waste gases such as carbon dioxide and the pH probes monitor the pH and acid base inlet adjust the pH to optimum. The product is extracted through the harvest drain.
- A fermenter thus provides all optimum conditions to culture the microorganisms to obtain the product.

15. Relationships of organisms with one another and with the environment

Ecology is the branch of biology that explains the relationships of organisms with one another and with the environment.

The part of the earth with living organisms is called as biosphere. The biosphere is further studied in small units called biomes of different habitats. (terrestrial biomes, aquatic biomes). The smallest unit of biome convenient to study is an ecosystem.

Ecosystem: The interaction of living organisms among themselves and with the physical environment of the habitat. Eg the aquarium with fish, water plants, the water, and the dissolved substances in water can be explained as an ecosystem.

Producer – an organism that makes its own organic nutrients, usually using energy from sunlight through photosynthesis. Example: green plants, green bacteria.

Consumer – an organism that gets its energy by feeding on other organisms. Example – all hetero trophic organisms such as animals and humans.

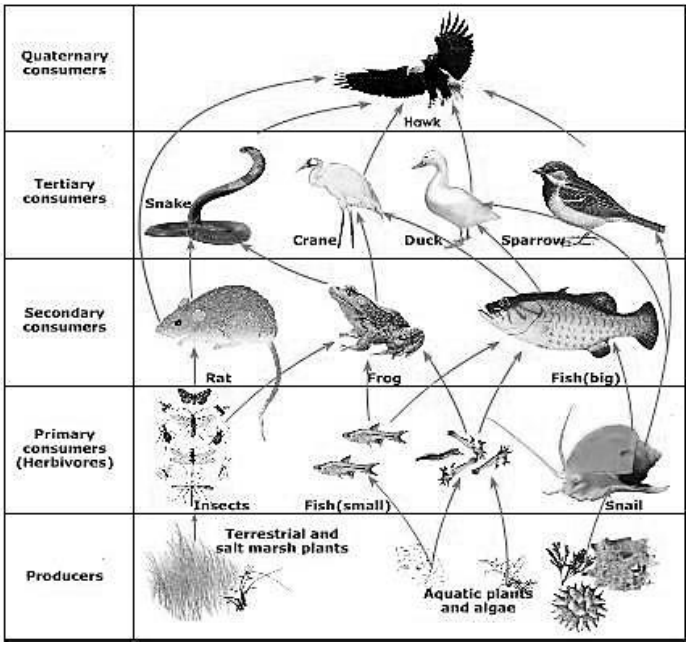
Herbivore – an animal that obtains its energy by eating plants; example- goat, giraffe and cow

Carnivore – an animal that obtains its energy by eating other animals; Example- lion and lynx

decomposer – an organism that obtains its energy from dead or waste organic matter; example- bacteria and fungi.

Food chain – a chart showing the flow of energy (food) from one organism to the next, beginning with the producer (e.g. mahogany tree → caterpillar → songbird → hawk);

Food webs: Many inter connected food chains of an ecosystem forms a food web. Food webs give us more information about the source of food of an organism and their relationship with other organisms in detail.

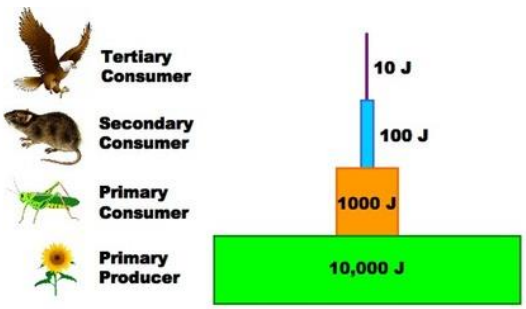


State that the Sun is the principal source of energy input to biological systems; Energy enters the food chains from the Sun. The Sun is the principle source of energy input to biological systems. Green plants absorb solar energy and convert it to chemical form during the process of photosynthesis. They use light energy to synthesize the organic molecules from simple inorganic nutrients water and carbon dioxide.

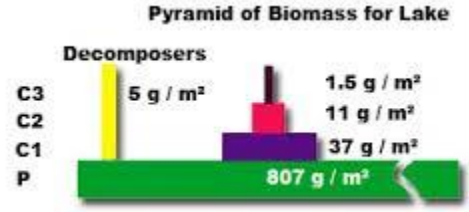
Describe the non-cyclical nature of energy flow;

- The solar energy fixed in autotrophs in the form of chemical molecules (carbohydrates, proteins and fats) is used by the plant for its growth and metabolism and is stored in plant parts. Some energy is lost as heat produced during respiration.
- The remaining energy is available for the consumers to feed. It is described that approximately 10% of the total energy present in the producers enter the primary consumers.
- From the primary consumers again about 10% would pass to the secondary consumers. This is because energy lost as heat during respiration and excretion (urine and feces).
- Hence the organisms at the end of food chain (top carnivores) receive very less amount energy. Food chains with less trophic levels are more efficient in energy flow and beneficial to the organisms rather than long food chains with many trophic levels.
- The energy of dead consumers and producers is available to the decomposers and lost as heat during their respiration and not recycled. Hence the energy flow in ecosystem is described as non-cyclic.

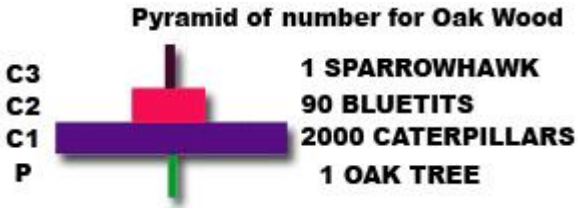
Describe and interpret pyramids of numbers and of biomass; food pyramids are the graphical or pictorial representation of food chains. They show the energy flow or biomass from one trophic level to other. **Pyramids of energy** are upright and base heavy. They show the amount of energy passed from one trophic level to other. The energy amounts of organisms in each trophic level are obtained to draw the pyramid.



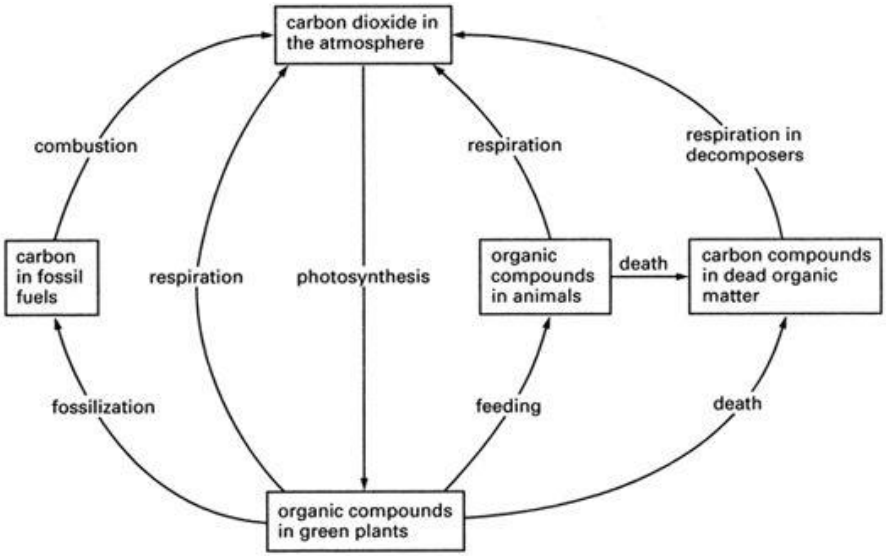
Pyramids of biomass: the mass of the organisms at each trophic level of sample area are recorded. These values are used to construct the pyramid. The pyramids of biomass are also upright and regualar. Their base is heavy with more biomass ofproducers. This pyramid show the loss of biomass from one tropic level to other. *[A position in a food chain or Ecological Pyramid occupied by a group of organisms with similar feeding mode is called as trophic level. For example, the primary producers are photosynthetic plants occupying the first trophic level. A group of organisms feeding on them is called herbivores, which form the second trophic level. Organisms feeding on the herbivores, called carnivores, occupy the next trophic level.]*



Pyramids of number: number of organisms at each trophic level sampled is used to construct the pyramid. The pyramid of numbers may not be always upright and regular. The pyramid shown here for oak tree ecosystem is base light. Sometimes a huge number of parasites feed on top carnivores' results in top heavy pyramids.



Describe and state the importance of the carbon cycle;

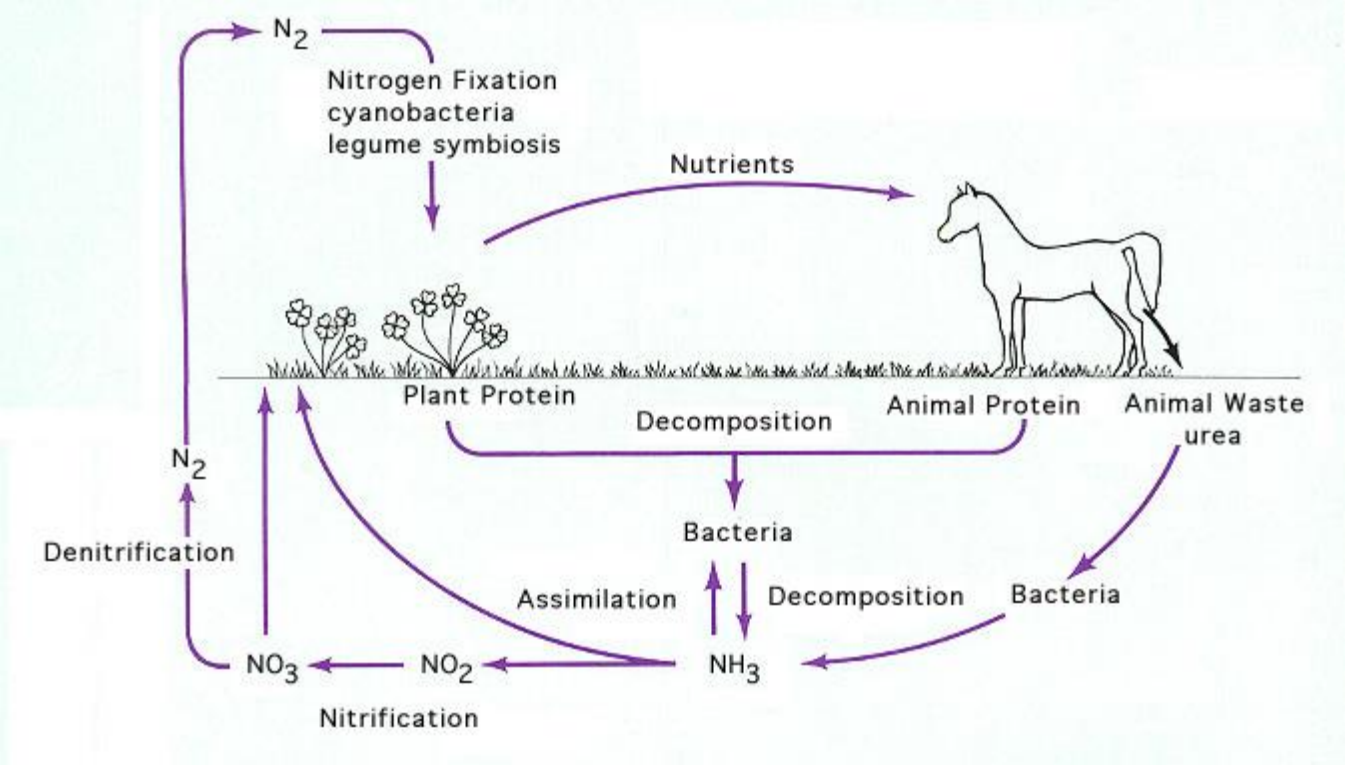


Biogeo chemical cycles shows the cycling of nutrients such as carbon and nitrogen between living organisms and environment. * *Carbon dioxide from atmosphere is removed by plants during photosynthesis. *carbon dioxide is added to the atmosphere when all the living organisms respire and breathe out, when fossil fuels are burnt and dead organisms are decomposed. *The recycling of carbon is important to maintain the carbon dioxide levels in the atmosphere. The removal and addition of carbon dioxide should be in balance.*

Describe the nitrogen cycle in making available nitrogen for plant and animal protein, including the role of bacteria in nitrogen fixation, decomposition and nitrification (details of denitrification and the names of individual bacteria are **not** required);

Nitrogen fixation: The process that remove atmospheric nitrogen by converting the nitrogen into ammonia and to nitrates. Rhizobium bacteria living the root nodules of leguminous plants (bean family) are involved in nitrogen fixation. This activity enriches the soil with nitrates and makes the nitrates available to the plants for absorption.

Feeding Plants synthesize proteins using the nitrates. The nitrogen in the form of nitrates passes into the herbivore animals while they feed on plants and then passes to the carnivores when they feed on herbivores. Thus nitrogen moves in the biological systems.
Decomposition or ammonification: bacteria in the soil feed on the excretory products of animals and dead plant and animal matter convert the nitrogen compounds into ammonia.



Nitrification: is the process of conversion of ammonia into nitrates by aerobic bacteria. This process enriches the soil with nitrates for the plants to absorb.
Denitrification: the conversion of soil nitrates into nitrogen gas under anaerobic bacteria. This process returns the nitrogen to the atmosphere.
Understand the role of the mosquito as a vector of disease; malaria is caused by a protozoan lives in ponds and stagnant waters. Mosquito acts as a vector to carry the malarial pathogen and infect humans. Mosquito breeds on stagnant water; the pathogen enters the mosquito larvae. When the larvae develop into adult mosquitoes fly and feed on humans. The female anopheles mosquito feeds human blood. While feeding it inject the pathogen into the human blood. The pathogen is transferred from infected person to healthy person when the mosquitoes feed on infected person and visit another human to feed.
Describe the malaria pathogen as an example of a parasite and describe the transmission and control of the malarial pathogen (details of the life cycle of the pathogen are **not** required);
Malaria is caused by a protozoan. The parasite enters the human blood and lives in the red blood cells. It is an endoparasite and causes harm to the host by damaging red blood cells. Mosquito also acts as ectoparasite.
Control Measures of malaria: - Against the vector (mosquito)

- Draining mosquito "breeding grounds" - marshes, swamps, ponds etc.
  This is never 100% effective, or even desirable, but it may be combined with other projects e.g.

colonization of land for agriculture, or civil engineering projects e.g. construction of railways or canals.

- Large scale spraying of wetland areas with insecticides to kill mosquitoes and larval stages has been quite successful (especially in the post-war years), even at the expense of environmental pollution. Some of the recent spread of malaria has been blamed on the cessation of use of DDT in some countries.
- Biological control - introducing fish to eat the mosquito larvae and pupae
  Gambusia affinis - often called the mosquito fish - is a small live bearing fish that is recommended in some instances as it can live in small bodies of water, although it may cause ecological damage by feeding upon other water organisms.
- Covering water with a film of oil .This kills the aquatic stages of the mosquito by preventing them from taking in air at the water surface.
- Spraying houses with insecticide
  Use of persistent insecticide [even DDT] on vertical surfaces has been found to be better than knock-down of flying insects.
  Evaporative dispensers of insecticides and insect repellants are often used by holidaymakers
- Fitting fly screens to windows
- Sleeping under nets, preferably soaked in insecticides

- against the parasite

Quinine - a product of the bark of the Cinchona tree - is the main ingredient in tonic water, a favorite drink (with gin!) for some people in hot places - a trend started by tea planters?
Chloroquine is used both to help prevent and treat malaria - it should be started 1 to 2 weeks before travelling into an area in which malaria is present. It should be taken the entire time in the area, and for 4 weeks after leaving.

<u>Describe the effects of humans on the ecosystem with emphasis on examples of international importance (tropical rain forests, oceans and important rivers);</u>

Land clearance for human activities such as housing, urbanization, industrial development and agriculture and transport has a great impact on the ecosystems. The main purpose of these activities is providing food, shelter and other needs for the growing human populations. But this can upset the balance in the ecosystem.

Land clearance can lead the following changes in the ecosystem:

1. Loss of natural habitats: the action of clearing tropical forests for agriculture and urbanization destroy the natural habitats and many species of plants and animals lose their habitats. Some species may be greatly reduced in number and in danger of extinction (endangered species).
2. Disruption of water cycle and pollution: deforestation and use of fertilizers and pesticides have adverse effects on aquatic ecosystems. Since water moves in a cycle between evaporation and

condensation, the water cycle of the area is affected. In extreme cases desert may be created in such areas. Discharge of industrial wastes and leaching of non-biodegradable waste causes water pollution.

3. Creation of an artificial ecosystem: growing similar kind of crop over and over in the land, eventually changes the feeding relationships of food chains. Land fertility will be lost. Soil erosion may occur.

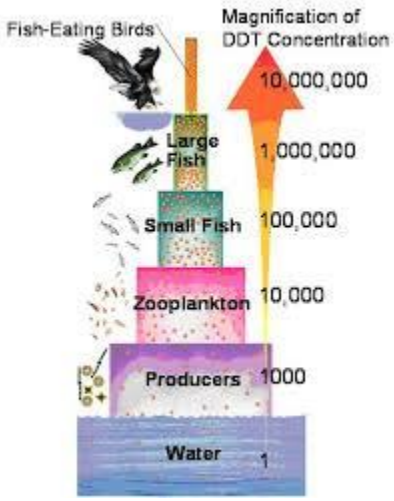
Describe the consequences of deforestation in terms of its effects on soil stability, climate and local human populations

- Deforestation and soil stability: The plant roots hold the soil particles while anchoring themselves in the soil. When the trees are cut down the soil gets loose and can be washed away by wind and water. The top soil will be lost during this erosion the mineral and humus of the soil is lost. The soils become unfertile.
- Deforestation and climate: the trees also shield the water flow during heavy rains as their canopies obstruct the force of water. When trees are not there rain water floods. Plant transpiration contributes to a considerable amount of cloud in the atmosphere. Reduced transpiration thus disturbs the rainfall patterns. Plants also remove carbon dioxide from the atmosphere while photosynthesizing. Lack of trees in the ecosystem increases the greenhouse effect and leads to global warming.
- Deforestation and local human populations: many human tribes depend on forest wealth and obtain forest products for trade and daily needs. Loss of forests adversely affects the occupation of these populations. Urbanization makes it difficult for the rural people to adapt for new conditions and migration of these populations to nearby towns and cities increases competition for resources.

  Evaluate the effects of: water pollution by sewage, by inorganic waste and by nitrogen-containing fertilizers; air pollution by greenhouse gases (carbon dioxide and methane), contribruting to global warming; air pollution by acidic gases (sulfur dioxide and oxides of nitrogen), contributing to acid rain; pollution due to insecticides

- Water pollution by sewage by inorganic waste and nitrogen containing fertilizers leads to eutrophication in aquatic habitats. The aquatic plants absorb there nutrients and grow rapidly. This growth of plants on surface of the water blocks the light and the bottom dwelling phytoplankton die. The decomposition of the dead increases the bacterial populations. The oxygen dissolved in water is not sufficient for the animals. This leads to the decrease in the animal populations due to competition for obtaining oxygen for their respiration.
- Air pollution by greenhouse gases: oxides of nitrogen and sulphur released by factories dissolve in rain water and causes acid rains. Presence of these gases in air and rain irritates the eyes, lungs, damage plant roots so that they cannot absorb the mineral nutrients by active transport. The leaves of plants also get damage due to acid rain and rate of photosynthesis reduces.

- Air pollution by carbon dioxide and methane: these gases are known as greenhouse gases as they absorb solar radiation and maintain the atmospheric temperature to be warm enough for the enzyme activities in living cells. The increased amount of these gases increase the greenhouse effect and causes global warming.
- The use of pesticides and chemical that have nonbiodegradable substances such as lead and mercury cause pollution on earth. Since these chemical are nonbiodegradable (not decomposed) they are absorbed into the plants by their roots. In plants they are not digested and enter into the bodies of consumers while they feed on plants. The toxins increase at each trophic level and increase to greater amounts in the top carnivores. This is called as bio magnification of toxins and is fatal to the organisms.



<u>Discuss reasons for conservation of species with reference to maintenance of biodiversity, management of fisheries and management of timber production;</u>

Human activities are leading to the loss of balance in the ecosystem. This is leading to the climate changes, species extinction and loss of natural resources, depletion of both renewable and non-renewable resources. The survival of living things including human is at risk. So there is a great need of conservation of species to maintain biodiversity. To protect the endangered species and restore ecological balance conservation is needed.

Management of timber production: forests supply many products for human. To manage to maintain forests. 1) the governments of nations have to legislations to control the indiscriminate cutting down of trees 2) only selected trees that are matured to be cut down by leaving the surrounding plants untouched 3) new plants are to be planted to compensate the loss (afforestation).

<u>Discuss reasons for recycling materials, with reference to **named** examples</u>.

With the increasing human population the needs for the people also increases. But the point of concern is that are there enough natural resources to service all your needs. What if these resources finish, this is one thing we need to ponder upon. We need to start recycling waste to converse our natural resources. Recycling is simply the process of reusing the items from which utility can still be derived. It is important to recycle waste so that you can at least converse some of our natural resources for our generations to come.

Many products such as paper, cardboards, and cups come from trees. In fact trees are our natural assets, you can converse trees by recycling the paper products we can minimize the number of trees cut down a year. This is one form of waste recycling. One should understand and know the importance of recycling waste materials. One simple benefit of recycling is it saves our resources. It will be wise to reuse metal item as metal reserves may be depleting. You can sold your wore out metal items for recycling. As mentioned earlier, recycling of waste papers can save our forests.

Recycling waste not only save our natural resources but also help save energy. By simply recycling an item or making a basic fix to it, we can we save all the energy that would have been consumed in the process of making it. The same example can be taken with plastic items. A large amount of energy can be saved by simply reusing the plastic items. To recycle waste is to simply reduce pollution. By recycling plastic material we can reduce air pollution as well as water pollution. Plastic factories produced large amount of smoke when producing plastic material at the same time if we don't have proper waste disposal system those waste emissions will cause water pollution. Recycling waste in a way helps reduce pollution.

In simple words, recycling or recycling waste is essential to both natural environment and humans. To sum up, recycling minimizes the need for raw materials so that the rainforests can be preserved. Great amounts of energy are used when making products from raw materials. Recycling requires much less energy and therefore helps to preserve natural resources. One needs to know the importance of recycling at the same time being earth friendly can help our planet a better place to live in. In simple words, recycling or recycling waste is essential to both natural environment and humans. To sum up, recycling minimizes the need for raw materials so that the rainforests can be preserved. Great amounts of energy are used when making products from raw materials. Recycling requires much less energy and therefore helps to preserve natural resources. One needs to know the importance of recycling at the same time being earth friendly can help our planet a better place to live in.

16. Development of organisms and continuity of life

(a) define *mitosis* as cell division giving rise to genetically identical cells in which the chromosome number is maintained and state the role of mitosis in growth, repair of damaged tissues, replacement of worn out cells and asexual reproduction;

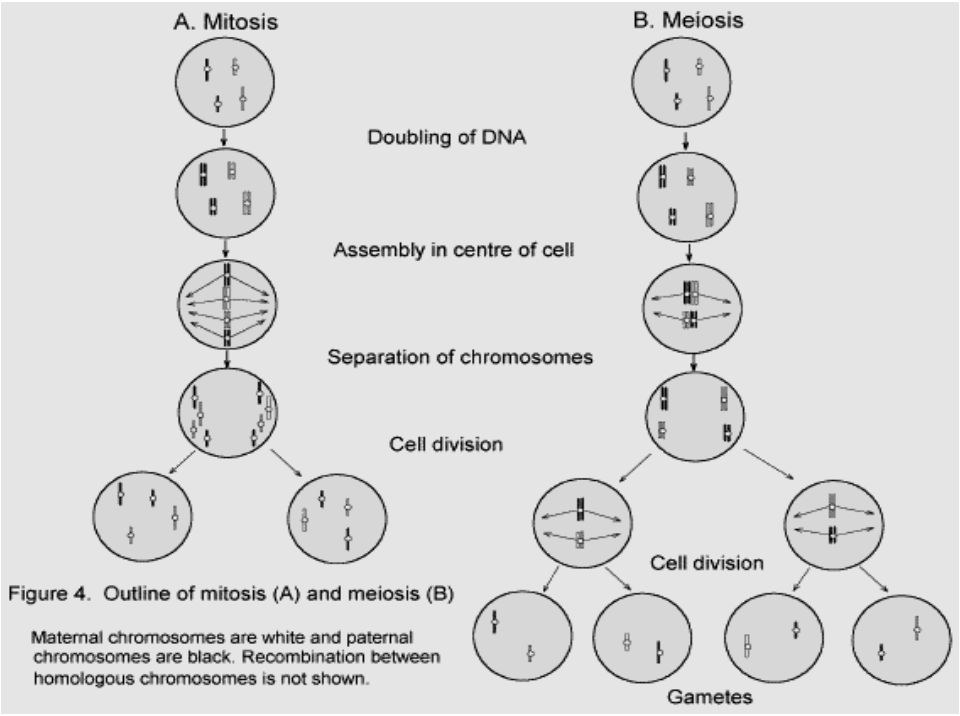


Figure 4. Outline of mitosis (A) and meiosis (B)

Maternal chromosomes are white and paternal chromosomes are black. Recombination between homologous chromosomes is not shown.

Cells divide to produce new cells. Cell division is important for the growth and reproduction of an organism.

Mitosis is a type of cell division in which a parent cell divides to form two identical cells.

Meiosis is a type of cell division that produces four daughter cells. The daughter cells contain half number of chromosomes than that of the parent cell.

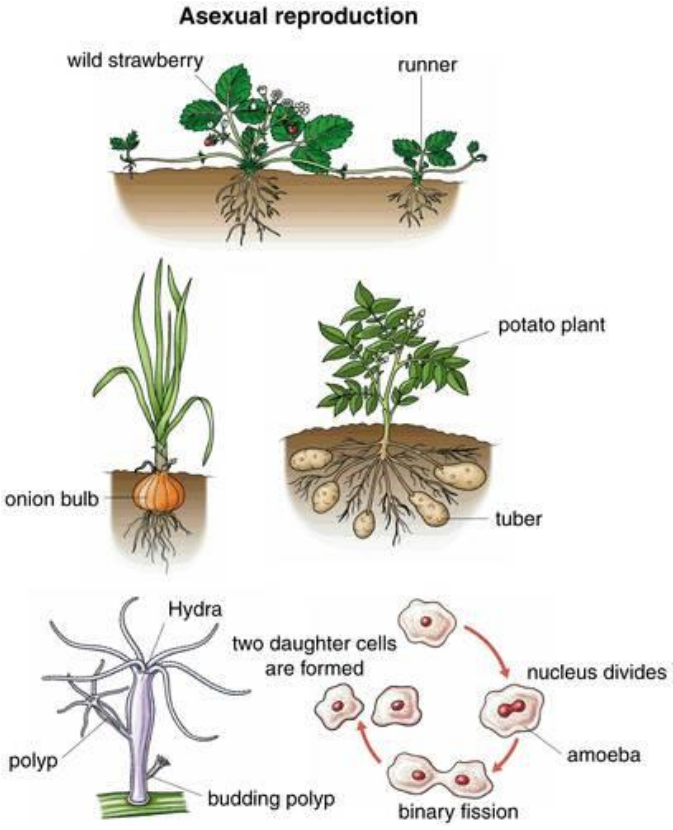
Mitosis (equatorial division)	Meiosis (reduction division)
This division occurs in somatic cells (body cells)	This division occurs in cells of reproductive organs
Two daughter cells are produced with diploid chromosomes as identical to the parent.	Four daughter cells are produced with haploid (half number) chromosomes.
There is no variation in alleles on the chromosomes of daughter cells.	Many variations are formed in the alleles on the chromosomes of daughter cells.
The newly formed cells cause the growth of organism and repair worn out tissues. Organisms reproduce by asexual methods also divide by mitosis.	The newly formed cells are called as sex cells (gametes) and fertilize to form zygote in sexual reproduction.
Example: the zygote after fertilization divide by mitosis to grow into embryo and the young babies and plants divide by mitosis to grow into adult organisms.	Example: in the anthers and ovary of the plant flowers this division occurs to form gametes. In animals this division occurs in testes and ovary (reproductive organs).

b) know what is meant by haploid and diploid conditions of chromosomes.

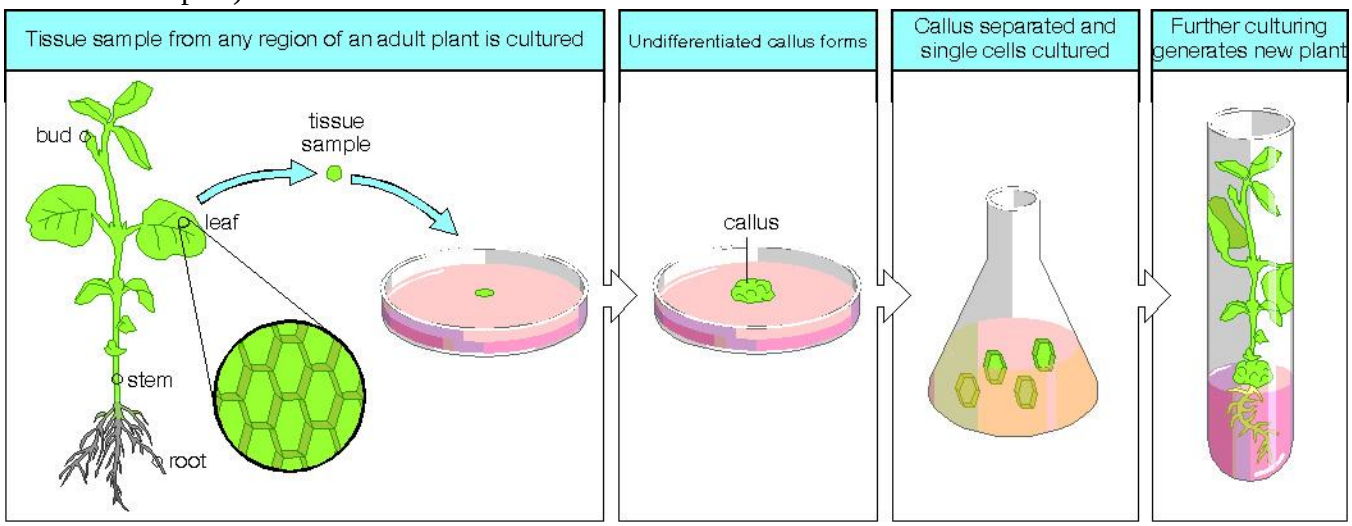
Diploid: all living cells have two sets of chromosomes acquired from both parents. The complete set of paired chromosomes in the nucleus is called diploid number. Represented by 2n or 2x.

Haploid: during meiosis cell division the chromosomes number is halved and one half of the parent cell chromosomes are distributed in the daughter cells. The new cells have only half the number chromosomes of parent. This condition is called haploid and shown as n or x.

(c) Define *asexual reproduction* as the process resulting in the production of genetically identical offspring from one parent and describe **one named**, commercially important application of asexual reproduction in plants;
Unicellular organisms, bacteria, fungi and some plants and some invertebrate animals reproduce by asexual methods.

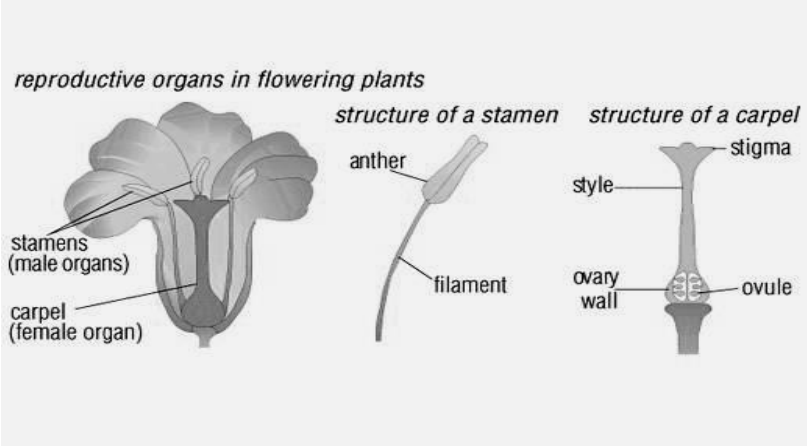


A plant reproducing by vegetative parts (from roots, stems, leaves and branches) is termed as vegetative propagation. If new plants are allowed to produce from the tissues it is called as tissue culture.
**Advantages of vegetative (asexual) propagation: ***new offspring can be produced by one parent only. * The offspring will exactly look like parents and retain the qualities of parents. This is important for commercial propagation to produce good quality of individuals. * Large number of individuals can be produced in less time as the sowing of seeds, germination are not involved. * Now a days new technology is able to produce plants from the tissues (small group of cells) by tissue culture. Farmers and gardeners can produce more plants and get commercial benefit. (Refer the diagrams to explain using named examples)



(d) Define *sexual reproduction* as the process involving the fusion of haploid nuclei to form a diploid zygote and the production of genetically dissimilar offspring;

During sexual reproduction two parents are involved. The gametes produced by the sex organs of male and female individuals are haploid. They fertilize (fuse) to form a diploid cell called zygote. This zygote develops into new organism. During meiosis alleles (genes) segregate in gametes, and while fertilizing also chromosomes coming from both parents will give new combination of alleles. This results in variation in the offspring. The new characters found in young ones enable them to adapt better to their environment and survive. They can colonize in new habitats successfully.
(e) Identify and draw, using a hand lens if necessary, the sepals, petals, stamens and carpels of **one**, locally available, **named**, insect-pollinated, dicotyledonous flower, and examine the pollen grains under a light microscope;
(f) State the functions of the sepals, petals, anthers and carpels;



Sepals- protect inner structures
Petals – cover the stamens and carpel. Large colorful petals attract insects and pollinate.
Stamens- consist of anthers that produce male gametes pollen grains.
Carpel- consists of ovary that produces ovules (female gametes)

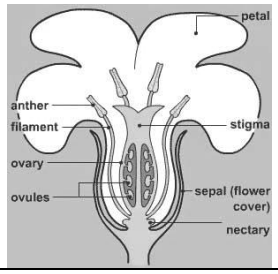
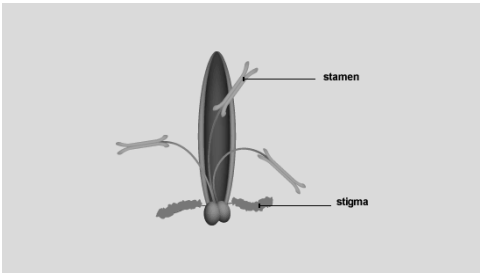
(g) Use a hands lens to identify and describe the anthers and stigmas of **one**, locally available, **named**, wind pollinated flower, and examine the pollen grains under a light microscope; dissect the anthers of a flower and collect the pollen from the anthers using a paint brush. Slowly drop the pollen on a glass slide and put few drops of sugar solution. Place a cover slip using a mounting needle and remove air bubbles. Observe the slide under the microscope.

pollen grains of wind pollinated flower

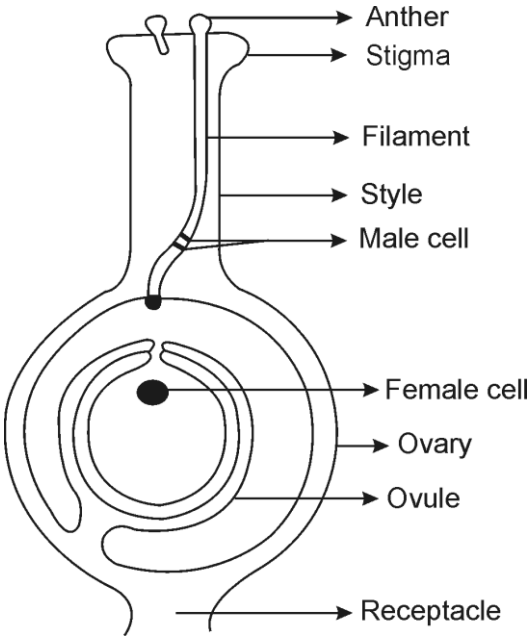
pollen garins of ensect pollinted flwoer.

h) outline the process of pollination and distinguish between self-pollination and cross-pollination; **pollination** is the transfer of the pollen grains from anthers to the stigmas. If pollen from anthers is transferred to the stigmas of the same flower it is **self-pollination.** Self-pollination is possible if the flower is bisexual (having both stamens and carpels) or if the heights of stamens and carpel are different and anthers and ovary produce their gametes at different times. If pollen from anthers of one flower is transferred to the stigmas of another flower of the same species it is **cross pollination.** This requires an agent like wind or insects to carry the pollen from flower to flower. Cross pollination results in more variations than self-pollination.

(i) Compare, using fresh specimens, an insect-pollinated and a wind-pollinated flower;

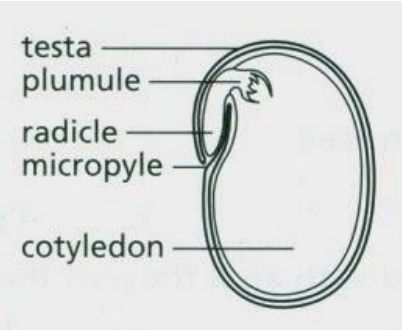
	
Sepals usually green and in outer whorl	Sepals are fused with petals and are green
Petals large, colorful, and attract insects.	Petals fuse with sepals and green in colour.
Stamens rigid, inside the flower	Stamens long and hanging out of the flower so that pollen can be carried by wind.
Anthers- small and produce less pollen.	Anther large and produce more pollen to overcome wastage.
Pollen large, rough outer coat to stick to the insect bodies.	Pollen is smooth, small and sometimes may have air bladders to be blown by wind.
Carpel – rigid and inside the flower.	Carpels open and seen out of sepals and petals.
Stigma flat so that insect brush the pollen on it	Stigmas are feathery or branched to catch pollen.
Nectarines- sometimes present for insect to feed	No nectarines.
Scent- some flowers spread sweet smell to attract insects	No smell.
Flower size – large and colorful	Very small and usually occurs as inflorescence.

(j) Describe the growth of the pollen tube and its entry into the ovule followed by fertilization (production of endosperm and details of development are **not** required);

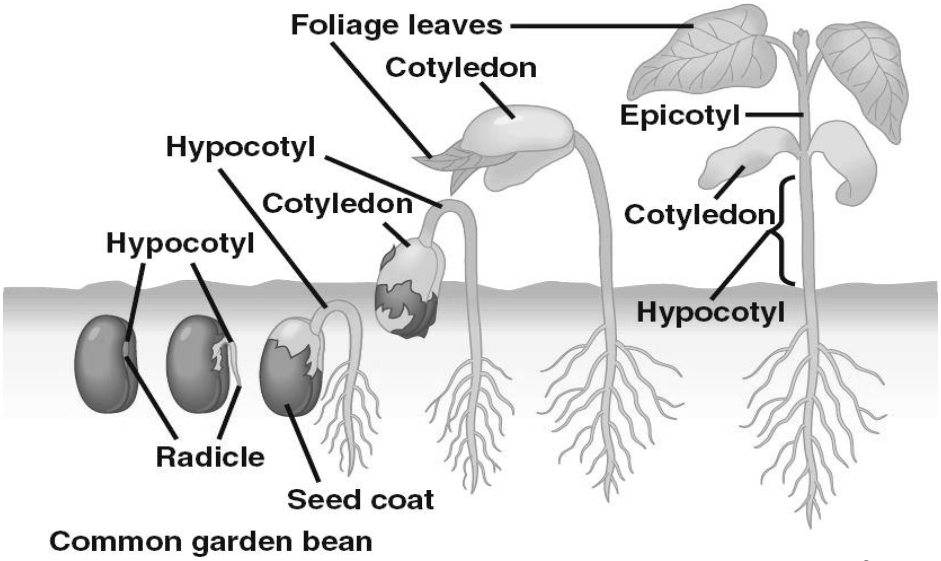


- The pollen lands on the stigma germinate to give a pollen tube.
- The pollen tube passes through the stigma and reaches to the ovary.
- The pollen tube carries the male nuclei to the ovule
- The pollen tube end breaks and releases the male nuclei into the ovule through micro pile.
- The male nucleus fuses with the female nucleus of ovule and form zygote.
- The fertilized ovum transform into a seed.
- The ovary swells and become fruit.
- In most flowers the other parts of the flower wither and fall off.

(k) Investigate and describe the structure of a non-endospermic seed in terms of the embryo (radicle, plumule and cotyledons) and testa, protected by the pericarp (fruit wall); the ovule wall becomes testa (seed coat). The zygote develops to form and embryo consists of radicle (grows into root), a plumule (shoot) and two cotyledons (food resource for growing embryo).



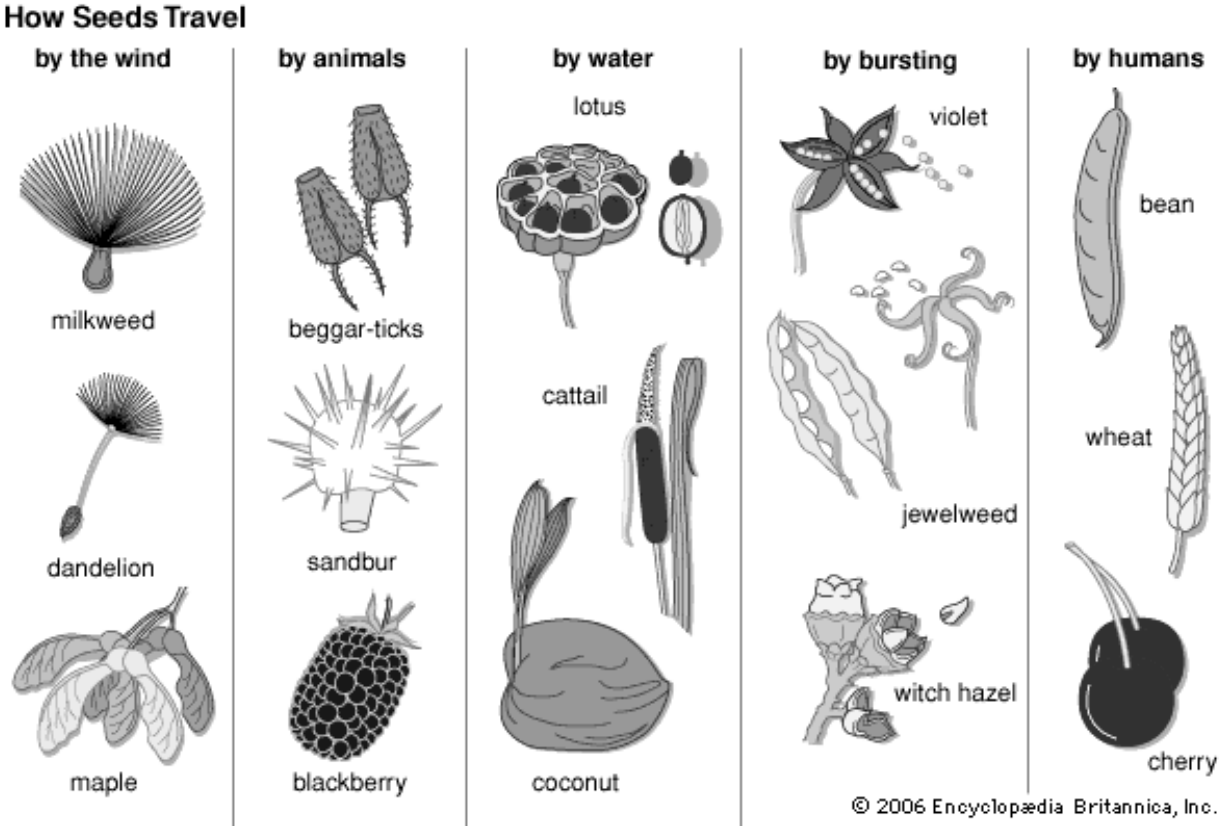
(l) Describe the uses of enzymes in the germination of seeds; the seeds when they are dispersed and get all favorable conditions. The conditions needed for germination are oxygen, optimum temperature and water.



Common garden bean

During the germination of seed, the seed absorbs water swells. Its mass increases. **Water** stimulates the enzymes to digest stored food starch, proteins and fats into simple soluble form and transport the digested foods to radicle and plumule. **Oxygen** is used for respiration to provide energy for the growth**. Optimum temperature** is needed to activate the enzymes to work best. The mass of cotyledons decreases during the germination as the stored food is used up. When the first leaves emerge the mass of seedling (baby plant) increases as the first leaves start to photosynthesize. The testa falls of when the radicle (first emerges) and plumule (next emerges).

(l) State that seed and fruit dispersal by wind and by animals provides a means of colonizing new areas;
Seeds that fall under the parent plant crowd and compete for water and other factors. After germination the seedling may not grow well because of the shade of parent plant. So they need to be dispersed away from parent plant to avoid competition and to get all favorable conditions.



Wind dispersal **Light weight**	Animal dispersal	Water dispersal	Self-dispersal	By humans
Have parachute like hairs and wings Maple fruits have wing like structures, dandelion and milk weed have tuft of hairs act like parachutes to fly in air.	Have spikes so that can stick to the bodies and hairs of animals Some may be colorful and fleshy, juicy to attract animals feed. They eat and discard the seeds in egestion as the testa is hard to digest.	Seeds are light weight and contain fibrous pericarp so that can float in water and disperse.	Fruits get dry and burst open with tension. The seeds are forced out of the fruit and are carried by wind. Seeds are light weight.	Fruits dispersed by humans are edible (eatable), fleshy and juicy. They eat the fruits and through or sow the seeds.

Human Reproduction

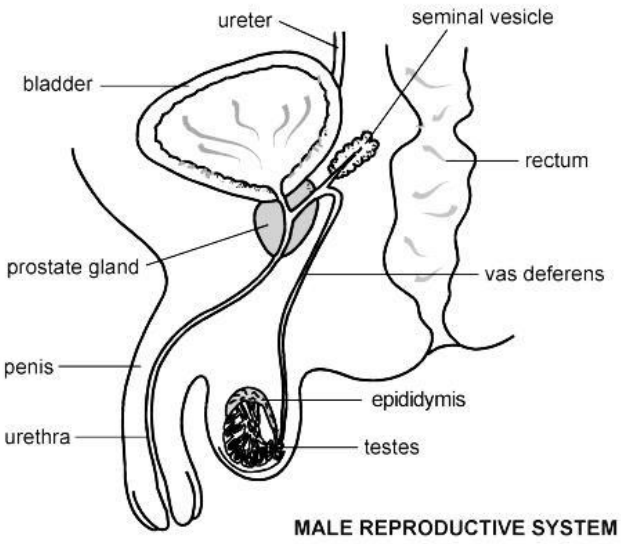
1. Identify on diagrams of the male reproductive system and give the functions of the testes, scrotum, sperm ducts, seminal vesicle, prostate gland, urethra and penis.

Testes- produces sperm my meiosis and secrete testosterone (male hormone)

Scrotum- loose skin covers the testis and keeps the testis hang out. This lower the temperature in testes by 2^0C, and suitable to store sperm cells.

Epididymis- highly coiled tube that connects testes with sperm duct. Sperm is temporarily stored here.

Sperm duct (vas deferens) – carry sperm from testis to urethra.



MALE REPRODUCTIVE SYSTEM

Seminal vesicle, prostate gland –secretes fluid consists of carbohydrate and alkaline chemicals. The sperm missed with seminal fluid is called semen when ejaculated on vagina maintain pH suitable for the sperm to survive.

Penis- consists of urethra and contractile muscles. Functions in ejaculating semen and transport the semen from sperm duct to vagina.

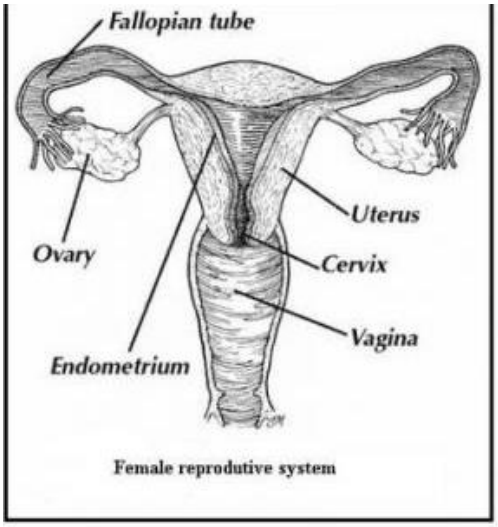
2. Identify on diagrams of the female reproductive system and give the functions of the ovaries, oviducts uterus, cervix and vagina.

Ovaries- produce female gamete egg or ovum by meiosis. Secretes hormones oestrogen and progesterone. These hormones prepare the uterus thick and ready for the development of foetus.

Oviduct (fallopian tube) - takes the egg released from ovary and fertilize with sperm cell and also transports the fertilized egg into the uterus.

Uterus- site of implantation and development of baby.

Uterus lining gets thicker during pregnancy and placenta forms for supplying the nutrients to the baby and remove waste materials.

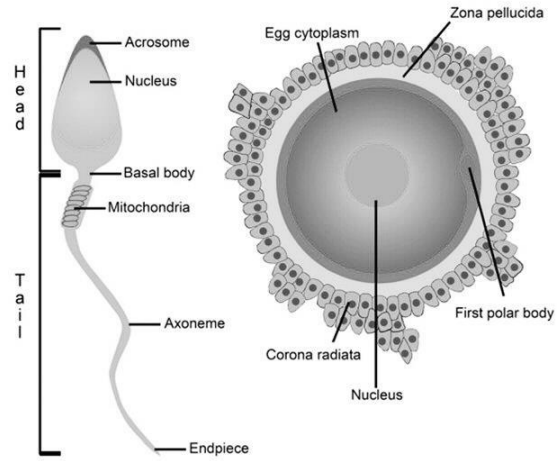


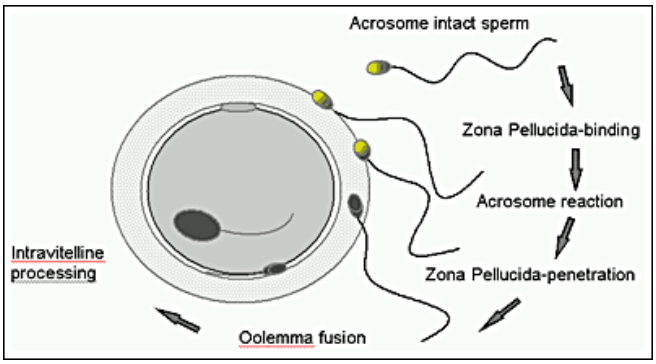
Female reprodutive system

Cervix and vagina- receive semen during ejaculation and passage for menstrual flow and baby birth.

3. Compare male and female gametes in terms of size, number and mobility.

SPERMATOZOON **OVUM**





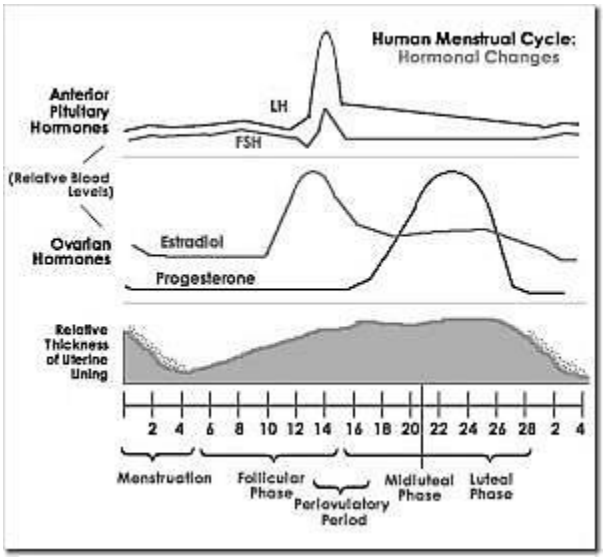
Sperm cell	Ovum (egg)
Size- smaller than ovum (5 micormeters) , small size easy to move And reach oviduct from vagina through uterus.	Larger than sperm.(100 to 200 micrometers) Contain more cytoplasm to provide nutrients for the development of egg after the fertilization
Number- larger in number, because there will be a lot of wastage during ejaculation and transport to oviduct. Producing in larger number increases the chance survival and fertilization	Produced in one at a time or few, not transported out of the system. Fertilization occurs in female reproductive system.
Mobility- has a tail to move so that can swim in semen from vagina to oviduct.	Cannot move by its own. But the moves by peristalsis of oviduct muscles to reach the uterus.

4. Describe fertilization and early development of the zygote simply in terms of the formation of ball of cells that becomes implanted in the wall of uterus.

The sperm head consists of acrosome which secretes enzymes to digest the protein coat of egg (zona pellucida) and enters into the ovum deliver the haploid nucleus. Fusion of male and female nucleus results in the formation diploid cell called zygote. The zygote divides by mitosis and develops into a ball of cells. The ball of cells moves down the oviduct to the uterus and gets fixed to the uterus wall (implantation).

5. Describe the menstrual cycle, with reference to alternation of menstruation and ovulation, the natural variation in its length and the fertile period and infertile phases of cycle.

6. Explain the role of hormones in controlling the menstrual cycle (including FSH, LH, progesterone and oestrogen).



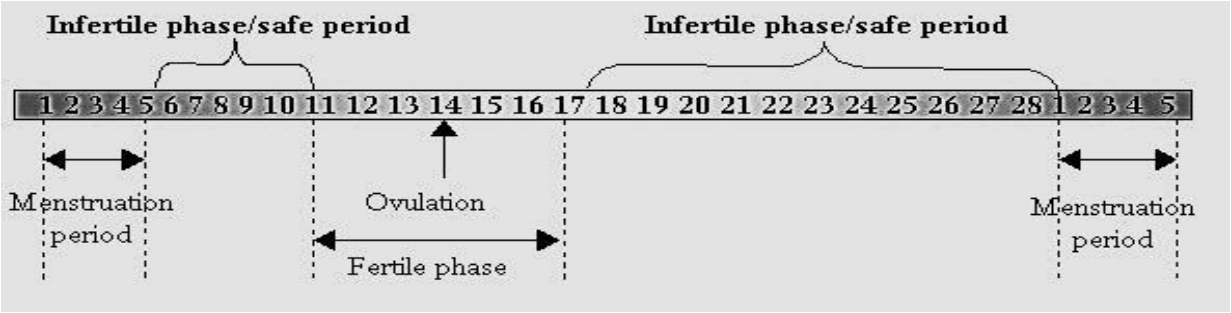
Menstrual cycle is the preparation of uterus for possible pregnancy. It is controlled by hormones and completes every 28 days in normal healthy females. The period may vary person to person in some cases. It occurs in four phases, four weeks.

(i) Menstruation or M phase- Week 1, lasts from 1 to 5 days. During this phase unfertilized egg with uterus inner wall (endometrium) breaks and discharges with a flow of blood out. During this phase no fertilization occur because no egg in the oviduct. Progesterone secretion is stopped.

(ii) follicle or f phase- week 2, (6 to 12days) During this stage pituitary gland secretes Follicle stimulating hormone to stimulate the ovary to produce a hormone called oestrogen and development of egg by meiosis. Oestrogen secretion inhibits the FSH secretion and initiates the thickening of uterus wall. This hormone stimulates the production of other hormone from pituitary called Leutinizing hormone (LH).

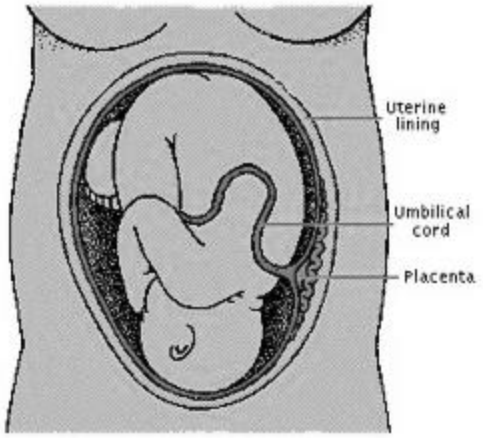
(iii) Ovulation phase- LH production stimulates the ovary release egg from the follicle. The release of egg from ovarian follicle is called ovulation. This occurs 13 to 15 days, but most likely to be on 14th day.

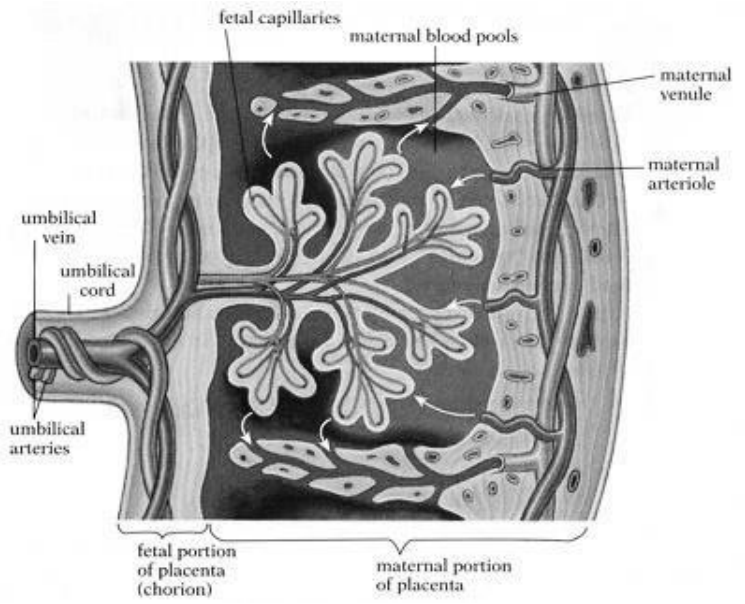
(iv) corpus luteum or L phase. (16 to 28 days)The follicle in ovary starts to produce progesterone. This hormone inhibits LH, so that another egg is not released. Progesterone also initiates the thickening uterine lining (endometrium) so that fertilized can be implanted in the uterus wall. If the egg is fertilized the implantation of embryo occurs between 16 to 21 days. If the egg is not fertilized, the corpus luteum degenerates and progesterone secretion stops and the menstruation begins.



7. State the function of amniotic sac and the amniotic fluid. The amnion is a membrane building amniotic fluid , sac that surrounds and protect an embryo .it is also the nourishing liquid. Amniotic fluid serves to cushion the unborn baby from jolts and bumps and unequal pressures. it provides a stable temperature and assists in maintaining a consistent body temperature for the unborn child. The fluid allows the baby to move freely and exercise growing muscles to develop a symmetrical musculoskeletal system.

8. Describe the function of placenta and umbilical cord in relation to exchange of dissolved nutrients, gases and excretory products.





The placenta is a unique organ formed from the tissue of foetus and mother's uterine tissue. The uterus that hold the baby and the placenta is located inside the uterus attached to the uterine wall. The umbilical cord and the blood vessels in it are connected to the placenta. The main function of the placenta is to provide a source of nutrients for the baby and provide blood supply to the baby. Essentially, it keeps the baby alive.

- The placenta increases the surface area for the exchange of substances between foetus and mother's blood.
- The uterine artery brings blood to the placenta. the nutrients like glucose, amino acids, fatty acids, hormones, antibodies and oxygen diffuse into the capillaries of the foetus and are carried to the foetus through umbilical vein.
- The waste materials such as urea and carbon dioxide formed during metabolic activities in the foetus are carried to placenta through umbilical artery. The waste substances from placenta then diffuse into the uterine vein.
- So the placenta acts as a respiratory organ, excretory organ, and immune system of the foetus.
- Placenta acts as a barrier between foetus and mother, and prevents direct contact of the mother's artery with the foetus blood vessel, so that the high pressure in mother's artery does not damage the foetus. It also prevents mixing of mother's blood and foetus blood as both of them may have different blood groups. Mixing of different blood groups may result in coagulation and collapse the foetus.
- The umbilical cord consists of umbilical vein and umbilical artery and connects the foetus with placenta. Umbilical vein carries oxygenated blood from placenta to foetus and the umbilical artery carries deoxygenated blood and urea from foetus to placenta.

9. Describe the special dietary needs of pregnant women:

- Eating healthily during pregnancy will help the baby to develop and grow, and will keep the pregnant woman fit and well.
- To meet the increased energy demands daily intake of carbohydrate should be increased.
- For the healthy growth of baby in the uterus mother has to take good protein sources.
- For efficient supply of oxygen to the baby through blood diet should contain more iron.
- Food intake of pregnant woman should contain enough fruits and vegetable to provide vitamins and minerals for the healthy growth of baby.

10. Describe the advantages of breast milk compared with bottle milk;

- Breast feeding provides all necessary nutrients to the baby in right proportions.
- The milk is at right temperature and also consists of antibodies to provide immunity.
- Its economical as parents need not buy milk.
- Breast milk is least contaminated and free of pathogens.
- Develops emotional attachment between baby and mother.
- Bottle milk is advantageous in case mother lacks breast milk, in mother's absence and it is easy to measure the quantity of feed. But not properly sterilized bottles, milk and different sources of milk can easily contaminate and may cause infections.

11. Describe the following methods of birth control: natural, chemical (spermicides), mechanical, hormonal and surgical.

Method	How it works	reliability
Natural or Rhythm	Avoiding intercourse during fertile period prevents fertilization and conception	Less reliable due to varying periods of menstrual cycle.
Chemical (spermicides)	Spermicide chemicals applied on vaginal passage kill the sperm when ejaculated and prevent fertilization	Less reliable in deeper ejaculation few sperm might survive and reach oviduct to fertilize
Mechanical (male and female condoms)	Creates a barrier for the semen to reach uterus and prevents fertilization. Protect from sexually transmitted diseases.	Less reliable due to possible damage to the condoms during storage temperature, type of material and quality.
Intra uterine devices	Small copper device placed in uterus prevents the fertilization and implantation	Most reliable but may have some side effects.
Hormonal (pills contain ovarian hormones)	Prevents the development of egg in follicles and ovulation and thus fertilization when taken regularly a pill a day after menstruation.	Less reliable as missing to take pill by chance results in ovulation and fertilization
Surgical	Vasectomy in males, by cutting the sperm duct and tying the ends prevents sperm transfer to the female. Tubectomy in females, oviducts are cut and ends are tied- prevents fertilization.	Highly reliable but irreversible.

12. Explain that syphilis is caused by a bacterium that is transmitted during sexual intercourse;;

13. Describe the symptoms, signs, effects and treatment of syphilis;

14. Discuss the spread of human immunodeficiency virus (HIV) and methods by which it may be controlled

Sexually transmitted Disease	Causative organism	Symptoms	Cure and prevention
Syphilis-	Trepanoma palladium (bacteria)	Sores on genitals during primary stage and infection might spread to nervous system, digestive and skeletal system in secondary stage	Treated by antibiotics, Prevented by not having sex with infected person and practice safe sex.
AIDS(Acquired Immunodeficiency Syndrome) Spread by *Having sex with HIV infected person *sharing needles of infected person *blood transfusion from infected to healthy *infected to mother to foetus. *sharing razor blades in barber shop.	HIV (Human Immuno-deficiency virus	Fever, headaches, and tiredness initially , later weight loss and suffer from other infections due to the reduced immune responses	No cure, but other opportunistic infections can be treated with antibiotics. Prevention: * prevent having sex with infected person or use condoms. * use sterilized needles and new blades. * screening of blood before transfusion. * infected mothers feed the babies with bottle feed.

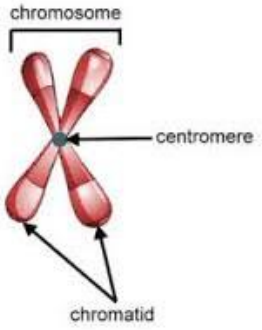
17. Inheritance

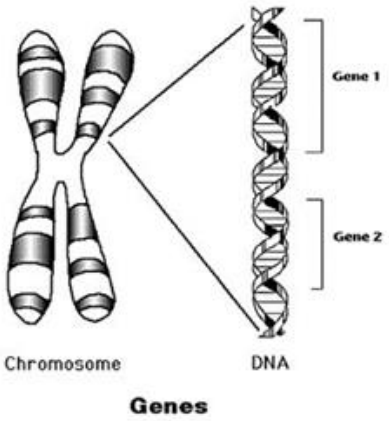
Inheritance in genetics helps us to study how offspring get the characteristics from their parents. Chromosomes consist of genes pass from parents to off spring (young ones born) during reproduction.

(a) State that a chromosome includes a long molecule of DNA;

(b) State that DNA is divided up into sections called genes;

The chromosomes are thread like structures made of chemical molecules called DNA (deoxy ribo nucleic acid). At the time of cell division the chromosome become short and have two chromatids joined at a point called centromere. The DNA consists of genes which are responsible for inheritance.





*(*c) Explain that genes may be copied and passed on to the next generation; During the cell division the chromosomes are distributed into the daughter cells. The genes are also copied and distributed. The genes in all body cells are diploid. The genes in gametes are haploid. There are about 2,500 genes in human chromosomes and are responsible for the inheritance of various characteristic features.

(e) define a gene as a unit of inheritance and distinguish clearly between the terms *gene* and *allele;*
(f) describe complete dominance using the terms *dominant, recessive, phenotype* and *genotype;*

Gene- a segment of DNA that determines one characteristic feature. One gene codes for one protein. Example: a gene inheriting height in the garden pea plant.

Allele- alleles are the alternate form of a gene. They usually occur in pairs in diploid. Example- the gene for height occurs in two forms tall and dwarf.

Homozygous: the condition of alleles in diploid with same type of alleles. Example: alleles for tall (**TT** each letter represent one allele, here tallness).

Heterozygous: the condition of alleles in a cell with two different alleles in diploid. Example (**Tt** each letter represent two alleles one for tall and one for dwarf)

Phenotype: The physical appearance and feature expressed in an organism is its phenotype. Example: the plant appeared to be tall.

Genotype: the composition of alleles in an organism is its genotype. Example: the plant may have allele for tall and dwarf inherited from both parents.

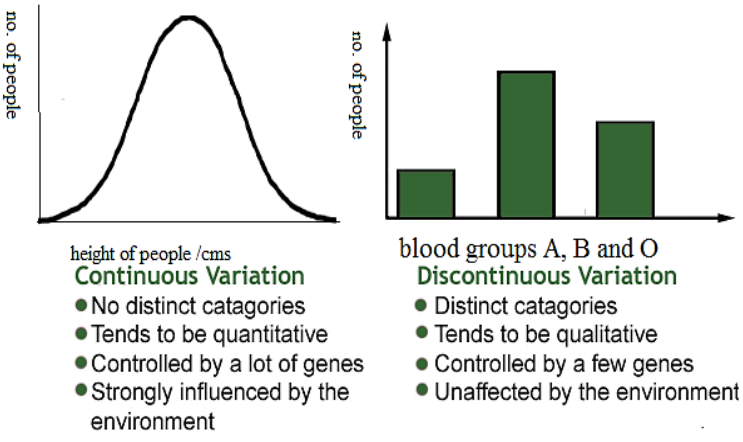
Dominant allele: the allele that can express itself to give a phenotype in heterozygous condition also. Example (Tt) a plant having an allele for tall and an allele for dwarf appears to be tall. The alleles are represented by writing the first letter of the feature T for tall. Dominant alleles are represented by capital letters (T).

Recessive allele: an allele that can express itself to give a phenotype only in homozygous condition. Example: (tt) the plant having two alleles for dwarf (short) condition can be dwarf. The recessive alleles are represented by simple case letters.

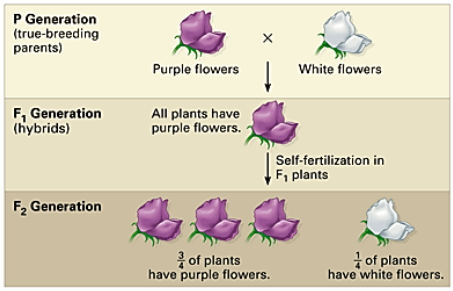
(d) Describe the difference between *continuous* and *discontinuous variations a*nd give examples of each

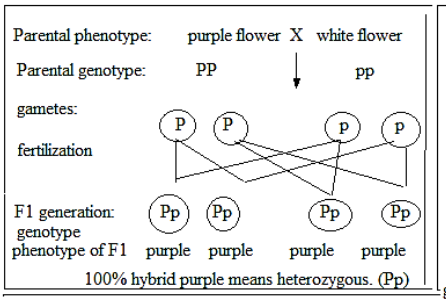
Continuous variations result in many intermediate phenotypes. (Medium height, tall, short). Examples: skin colour, intelligence and body weight.

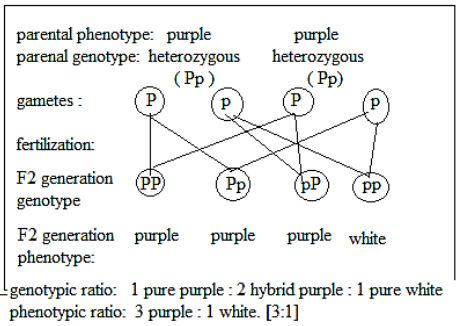
Discontinuous variations: occurs in two contrasting characters, without intermediate phenotypes. Example: blood group, gender and tongue rolling. (Refer the diagram to tabulate the differences.)



(i) predict the results of simple crosses with expected ratios of 3:1 and 1:1, using the terms *homozygous*, *heterozygous*, *F*1 *generation* and *F*2 *generation;*
(j) Explain why observed ratios often differ from expected ratios, especially when there are small numbers of progeny;
To understand and observe the mono hybrid inheritance (the inheritance of one characteristic feature an Austrian Monk John Gregor Mendel allow the garden pea plants with contrasting characters to breed by transferring the pollen from the anthers of purple coloured flowered plant to the stigmas of white flowered plants. Covered the flowers to prevent self- pollination. The flowers pollinated and produced seeds after fertilization. He germinated the seeds and observed the plants grown form the seeds. These plants are termed as F1 generation and all of them bear purple coloured flowers. By this he described

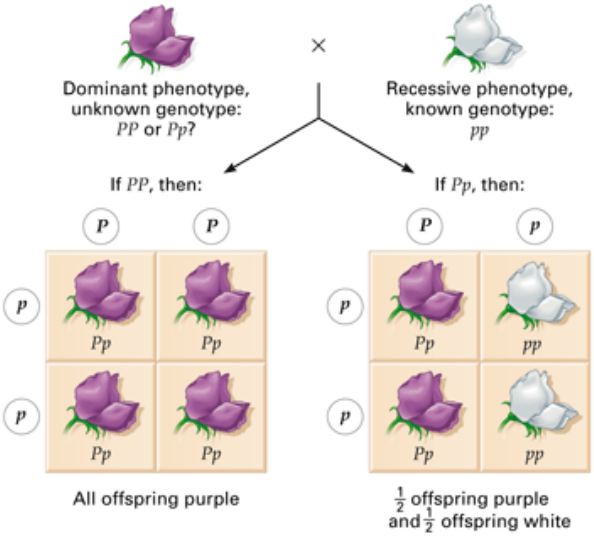






that purple colour allele is dominant over white. He allowed the heterozygous (hybrid) purple plants to self-pollinate and observed the next generation plants. 75% of them bear purple flowers and 25% of them were with white flowers. (Refer genetic diagram). These investigations help us predict the expected ratios of the results of different genetic crosses. * The expected ratios sometimes differ from the obtained ratios. This is because all seeds may not germinate, some germinated but die. The number of plants germinated may be small in number. For quick reference checker board or puunet square can be used instead of detailed genetic diagrams.

Test cross or back cross: we cannot know the genotypes of dominant phenotypes because the recessive allele is not expressed. Example the plant appears with purple flowers may have a genotype (PP) or (Pp). To know the genotype the organisms with unknown genotype can be crossed with a homozygous organism. The offspring if express two the phenotype of both parents we can conclude the dominant phenotype is heterozygous.



(k) Explain *co-dominance* by reference to the inheritance of the ABO blood group phenotypes (A, B, AB, O, gene alleles IA IB and IO); in a contrasting pair of alleles if neither allele is dominant the offspring will have new phenotype (different from both parents) such alleles are co-dominant alleles and the inheritance is co-dominant inheritance. Example: A group father and B group mother giving birth to AB group children. Inheritance of O group is recessive because there should be two alleles I^o I^o for an individual to pocess O group.

Blood type	Genotype	
A	I^A, I^O I^A, I^A	AO AA
B	I^B, I^O I^B, I^B	BO BB
AB	I^A, I^B	AB
O	$I^O\ I^O$	OO

AB X AO

	A	B
A	AA	AB
O	AO	BO

1/4 Type AB
1/4 Type B
1/2 Type A

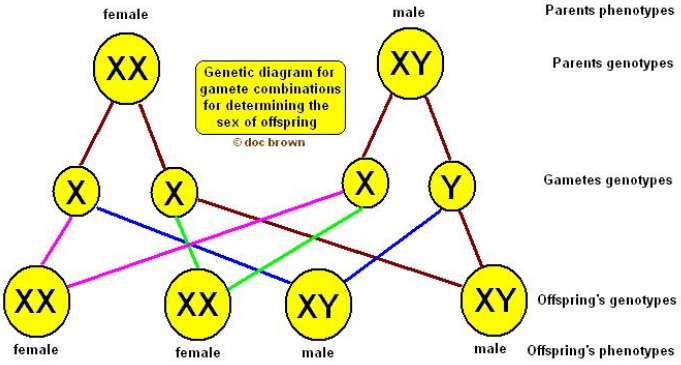
AO x BO

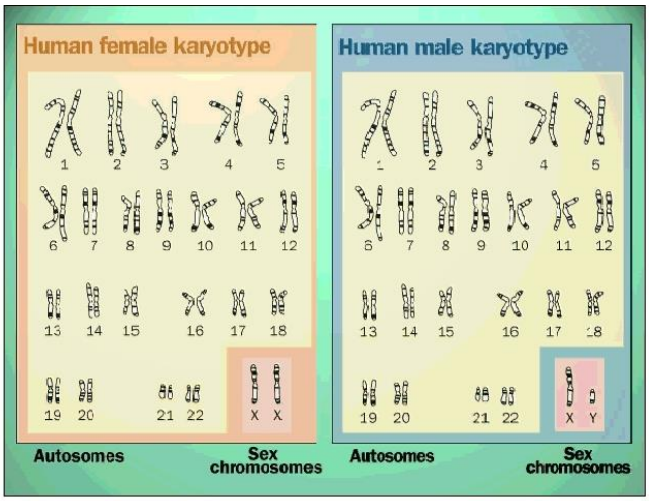
	A	O
B	AB	BO
O	AO	OO

1/4 Type AB
1/4 Type B
1/4 Type A
1/4 Type O

- If one parent is having AB group their children cannot have O group as each parent should have at least one allele for O to express O group.

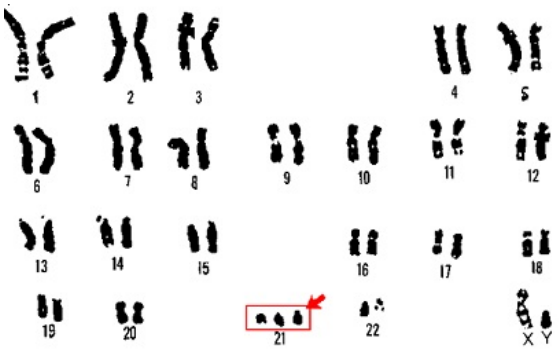
(l) Describe the determination of sex in humans (XX and XY chromosomes); human body cells have 46 chromosomes means 23 pairs. First 22 pairs (44) are called as autosomes and 23rd pair is called sex chromosomes. The autosomal chromosomes are homologous (have same shape and size. The sex chromosomes in females are homologous (same) and are called XX chromosomes. In male sex chromosomes contain one X chromosome and one Y chromosome. This pair is heterozygous means Y chromosome is smaller than X.



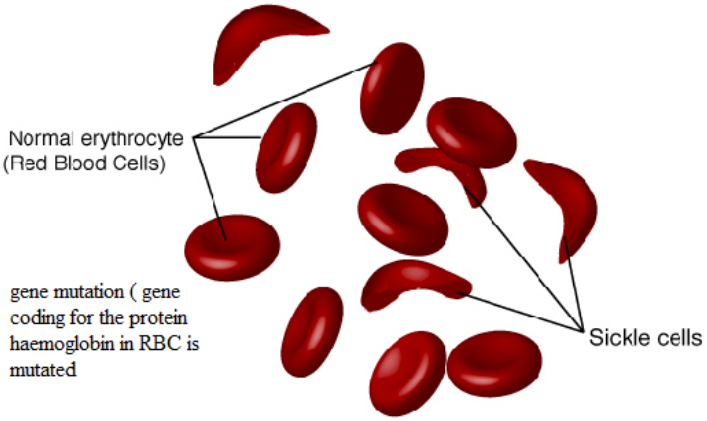


(m) Describe *mutation* as a change in the structure of a gene (e.g. sickle cell anemia) or in the chromosome number (e.g. 47 in Down's syndrome instead of 46); mutations are termed as change in the composition of DNA.

- If small part of the DNA (gene) is changed it is called **gene mutation**. Due to gene mutations the protein coded by the gene does not function normal and result in a disease. Example: sickle cell anemia. The red blood cells shape distorted to sickle and they cannot carry enough oxygen.
- If there is a change in chromosome number such changes are called as **chromosomal mutations.** Example: Down's syndrome. The person with Down's syndrome consists of 47 chromosomes as one extra chromosome is added to the 21st pair. This occurs when an abnormal ovum with 24 chromosomes fertilizes with a normal sperm cell forming a zygote with 47 chromosomes, and develop into Down's syndrome baby.



Down syndrome (extra chromosomes in 21st pair) abnormal ovum with 24 chrmomosomes fertilize with sperm cell prodcues a diploid zygote with 47 chromosomes which develop into Down's syndrome baby.

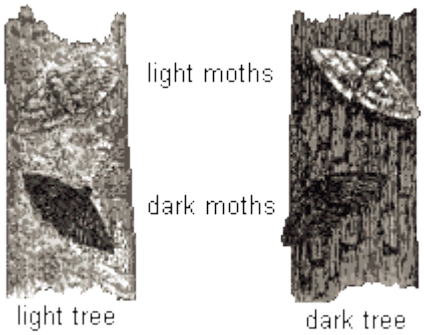


(n) Name radiation and chemicals as factors that may increase the rate of mutation; The factors that cause mutations are called mutagens. Example: UV radiation, radioactivity and chemicals such as mustard gas are some mutagens.

(o) Describe *variation* and state that competition leads to differential survival of organisms, and reproduction on by those organisms' best fitted to the environment; the changes in the phenotypes of the offspring during sexual reproduction are termed as variations. Individuals of a species have variations in their phenotypes due to mutations and allele recombination during sexual reproduction. Mutations are not always harmful to the species but results in best variations that make the organisms to adapt to new environment. The organisms with best variations can be successful in the competition and survive harsh environmental conditions.

(p) Assess the importance of natural selection as a possible mechanism for evolution; the survival of organisms in the changing environment is called natural selection. That means nature has selected the phenotypes which are best to survive. The organisms with phenotypes that cannot adapt better die.

Example: the peppered moth in England had mutation in their wings. The normal moth had light brown coloured wings by which the moth can camouflage in the tree trunks which are covered by lichens. A mutation in the allele resulted black spots on their wings. These moths were unable to camouflage and became prey for birds. When this area was industrialized the tree trunks were coated with black smoky soot. Now the black moths camouflaged well on the polluted area and survived. Their population increased.



(q) Describe the role of artificial selection in the production of economically important plants and animals;

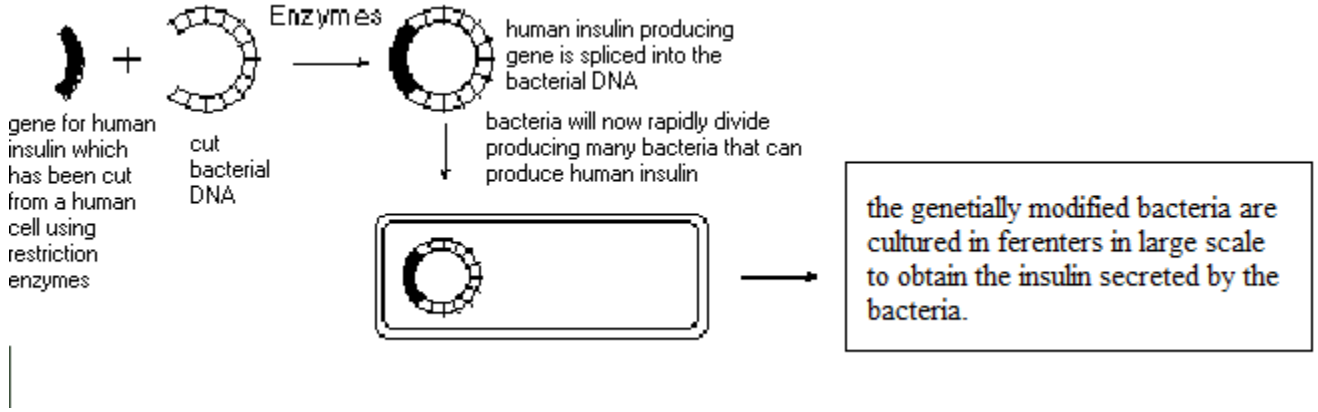
Understanding the natural selection humans have applied this to select the best organisms to breed and cultivate to obtain best plant and animal products. This is called as artificial selection.

big healthy seeds are selected and sowed

sheef with thick wool of male and female are selected and bred to obtain good qualities of wool.

(t) Explain that genes may be transferred between cells (reference should be made to transfer between organisms of the same or different species); *(u)* Explain that the gene that controls the production of human insulin can be inserted into bacterial DNA; *(v)* Understand that such genetically engineered bacteria can be used to produce human insulin on a commercial scale;

Genetic engineering: cutting the gene from the DNA of one species and inserting it in The DNA of other organism means the technique of changing the genotype of an organism. The genes are cut my molecular scissors, the enzymes called restriction endonucleases. The cut fragments of DNA are joined by enzyme ligases.



(w) Discuss potential advantages and dangers of genetic engineering.

Advantages: genetically modified organisms are used to manufacture hormones and extra cellular enzymes which can be used as drugs. The genetic engineering also helps us to produce organisms which produce good quality and high yield of plant and animal products.

Dangers of genetic engineering: The bacterial plasmids and vectors used to transplant the gene into the organism may turn out to be harmful to it as unpredictable change in gene may infect or cause cancers. The genetically modified organisms may also affect the balance in the populations as it disturbs the food chains.