FIRST TERM 2024/2025 SESSION

BIOOGY NOTE FOR SS2

SCHEME OF WORK

Lesson One: Digestion System

Lesson Two: Feeding Habit and Dentition

Lesson Three: Respiratory System

Lesson Four: Excretion

Lesson Five: Osmoregulation

Lesson Six: Skin

Lesson Seven: Hormones

Lesson Eight: Structure and Function of Gonads

Lesson Nine: Twin

Lesson One

DIGESTIVE SYSTEM

Feeding is very important to all living things (plants and animals). Plants are provided by nature with a system for making their own food from inorganic substances while animals depend principally on plants or other animals for their food. They therefore need a system which can breakdown the complex food substances to simpler ones for easy assimilation and the system is called digestive or alimentary system.

What is digestion?

Digestion is the process by which complex food substances are broken down with the help of enzymes into simple soluble forms which can be absorbed into the blood stream.

Classes of enzymes

Enzymes are classified according to the type of food they are on:

i. Amylase: These acts on carbohydrate, converting starch to glucose
ii. Lipase: These acts on fatty food substances, converting fats and oils to fatty acid and glycerol.
iii. Protease: These acts on protein converting proteins to amino acids

Sometimes enzymes are grouped according to the type of reaction they catalyse. Enzymes that catalyse transfer of atoms or group of atoms from one molecule to

another (e.g. hydrogen phosphate or amino group) are known as "Transferase" and they play important part in energy production and other metabolic processes in cells. Enzymes that specifically catalyse the removal of hydrogen atoms from a substrate are called Dehydrogenases and those that catalyse the addition of oxygen to reaction called oxidases. Both of the above mentioned enzymes are required in respiration.
In mammals the process of feeding involves:

1. Ingestion: This is the taking in of food through the mouth
2. Digestion: This is the breaking down of complex food into smaller, simpler form which can be easily absorbed into the blood stream by the aid of enzymes.
3. Absorption: taking in or diffusion of digested food through the walls of the small intestine into the blood stream.
4. Assimilation: Is the use of absorbed digested food to produce energy for body metabolic activities
5. Egestion: Is the removal of undigested food through the anus.

A typical mammalian alimentary canal incudes

i. Mouth
ii. Pharynx
iii. Gullet / Oesophagus
iv. Stomach
v. Small intestine
vi. Large intestine/ Colon
vii. Caecum
viii. Rectum
ix. Anus

All these parts can be found in most vertebrates but there are some modification of different parts of the alimentary tract is different animals. In some animals, the parts may be reduced or enlarged while in others the parts may be absent.

Animal	Mouth	Pharynx	Gullet	Crop	Stomach	Small intestine	Large intestine	Caecum	Rectum	Anus
Planaria	P	P	A	A	A	P	P	A	A	A
Earthworm	P	P	P	P	A	P	A	P	P	P
Cockroach	P	P	P	P	A	P	A	P	P	P
Fish	P	P	P	A	P	P	A	A	P	P
Toad	P	P	P	P	A	P	A	A	P	P
Lizard	P	P	P	A	P	P	A	P	P	P
Bird	P	P	P	P	P	P	A	P	P	P
Rabbit	P	P	P	A	P	P	P	P	P	P
Cow	P	P	P	A	P	P	P	P	P	P
Man	P	P	p	A	P	P	P	P	p	p

The human digestive system or alimentary canal

Omnivores

The parts of the digestive system or alimentary canal of man are:

i. Mouth / buccal cavity
ii. Gullet / oesophagus
iii. Stomach
iv. Duodenum
v. Ileum
vi. Large intestine
vii. Rectum
viii. Anus

Drawing of the human alimentary canal

Mouth (Teeth tongue and saliva)

The floor of the mouth bears a long muscular tongue which is sensitive to taste. The mouth collects or holds ingested food. It contains salivary gland which secretes saliva.

The teeth are found in the mouth on the upper and lower jaws. It is used for breaking down or masticating or chewing food into smaller particles thus creating a large surface area for enzymes to act on, as well as for easy swallowing.

Tongue

The tongue mixes the food with saliva and rolls it into a bolus / ball for easy swallowing.

Saliva

The saliva is an alkaline fluid that is secreted by the salivary gland. It moistens / lubricates the food particles, making it soft and easier for swallowing. It also dissolves solid food substances. It contains the enzyme ptyalin which requires the alkaline medium to carry out it actions. The enzyme ptyalin start the digestion of carbohydrate by acting on cooked starch converting it to maltose for further digestion in the small intestine.

Pharynx: It is a short muscular passage connecting the mouth with the oesophagus

Oesophagus / gullet

This is narrow collapsible tube. It is muscular. It does not contribute to digestion but merely serves to conduct food downwards. Its inner wall is lined by mucus membrane which enhances passage of food. Food travels down the oesophagus by wave-like contraction of muscles of the oesophagus called peristalsis. With the exception of the stomach, the whole alimentary canal exhibits peristalsis movement. Sometimes, food moves backwards or is regurgitated into the mouth from the stomach; in this case, anti-peristalsis occurs in the alimentary canal.
Peristalsis is the successive involuntary contraction and relaxation of the muscle of the digestive tract creating a wavelike contraction which push the content of the tract forward.

Stomach

The walls of the stomach is muscular with 2 sphincters, the cardiac sphincter at the anterior end and pyloric sphincter at the posterior end leading into the small intestine.
In the stomach, food is mixed up due to the contraction and relaxation of the muscular walls (churning of food).
The PH of the stomach is 6. Digestion of protein start in the stomach.
The wall of the stomach contains the gastric gland which secretes the gastric juice.
The gastric juice contains two enzymes:

(a) Pepsin: It is secreted as pepsinogen but converted to pepsin on contact with dil Hydrochloric acid
(b) Rennin: It acts on milk protein converting it into thick curdles (insoluble casein)

NOTE: Zygmogen are inactive enzymes e.g. pepsinogen and trypsinogen
The co-enzyme for pepsin is dilute Hydrochloric acid
The co-enzyme for trypsin is Enterokinase

Functions of Hydrochloric acid

i. It provides an acidic medium for the action gastric enzymes
ii. It neutralizes the alkaline saliva stopping the action of ptyalin
iii. It kills bacteria that might have entered the stomach with the food
iv. It stops food from decaying, that is, it prevents putrefaction

Pepsin acts on proteins converting it to peptones (i.e. intermediate products in protein digestion).
Rennin coagulate milk proteins into thick curdles. It does this by acting on the soluble milk protein (caseinogen) and converting it into insoluble casein. The casein is then broken down by pepsin. This action is important in infants whose main diet is milk.
The food is retained in the stomach for 3-4 hours. The food at this time is now thick, creamy fluid called chyme and it is acidic. It moves out through the pyloric sphincter into the first part of the small intestine (duodenum) by peristalsis action. The stomach also acts as a temporary storage of food.

Functions of the Stomach

1. It stores food temporarily
2. It secretes gastric juice containing dilute Hydrochloric acid, Pepsin and Rennin
3. Dilute Hydrochloric acid provides acidic medium for protein digestion
4. Dilute Hydrochloric acid destroys harmful bacteria in the stomach

5. Rennin curdles milk
6. Pepsin digests proteins into peptides/ peptones in the stomach
7. Stomach carries out churning of food.

Large particles of food are churned and broken down to smaller particles by the contraction of the stomach muscle or it carries out churning.

Small intestine

This is divided into (3) three

i. Duodenum
ii. Jejunum
iii. Ileum

Duodenum

It is the first part of the small intestine. It has 2 alkaline juice which helps in digestion. They are:

i. Bile: contains no enzyme
ii. Pancreatic juice (contains 3 digestive enzymes)

Pancreas is made up of diffused lobes lying the lobe of duodenum.

Bile

It does not contain digestive enzymes and it is secreted by the liver and stored in the gall bladder. It is a greenish alkaline liquid or bile salt. It has a pH of 8 and it contains excretory pigment formed from haemoglobin or dead red blood cells.

Function of bile

i. It neutralizes the acidic chyme food leaving the stomach thereby stopping the action of gastric exzymes.
ii. It is the best alkaline medium action of pancreatic enzymes because of its alkaline PH (8)
iii. Bile emulsifies fats and oils to tiny oil droplets of fatty acid and glycerol thereby reducing the surface tension of fats and oils.
iv. It prevents putrefaction or the decay of food in the small intestine. It has a high percentage of water, thereby adding water to the chyme and becomes chyle.

Pancreatic juice

This is secreted by the pancreatic gland found in the pancreas. It is alkaline and contains 3 digestion enzymes:

i. Pancreatic Amylase (amylopsin)
ii. Trypsin
iii. Pancreatic lipase

Emulsification is the breaking down of fats and oils into tiny oil dropletsto increase the surface area for action of enzyme Lipase this is carried out by bile which is secreted by the liver.

Pancreatic Amylase: converts the remaining starch into maltose
Trypsin: converts peptones to polypeptides
Pancreatic Lipase: converts emulsified fats and oils into fatty acid and glycerol.

The products of amylase and trypsin cannot be absorbed, but the fatty acids and glycerol can be. In fact, pancreatic juice is the main source of lipase and completes the digestion of fat.
Pancreatic juice also contains nucleases which breakdown nucleic acids into nucleotides. However, protein digestion is completed mainly by enzymes produced in the wall of the intestine.
Pancreas also contains hormone insulin, glucagon that regulates the amount of glucose in the blood. The food is now more watery and it is called chyle.

Pancreas as an Endocrine gland

Inside the pancreas, we have Islet of Langerhan which secrets two hormone, namely;

i. Insulin
ii. Glucagon

When there is excess blood glucose, the pancreas secrets insulin to convert glucose to glycogen

Glucose —(Excess blood glucose; Insulin)→ Glycogen

Glycogen —(Low blood glucose; Glucagon)→ Glucose

Ileum

This is the last part of the small intestine and also the longest part of the alimentary canal. The walls of the small intestine is made up of villi and blood vessels. The intestinal gland secretes intestinal juice which contains digestive enzymes that completes the digestions of protein and starch. Intestinal juice is also known as succus entericus. They are:

i. Lactase: converts lactose (milk sugar) to glucose + galactose
ii. Maltase: converts maltose to glucose +glucose
iii. Sucrase: converts sucrose the glucose + fructose
iv. Erepsin: converts peptone / polypeptides to amino acid
v. Intestinal Lipase: Converts emulsified droplets of fat and oil into fatty acid and glycerol.

The importance of a long small intestine is to provide a large surface area for digestion and absorption of food substances.
Note: glucose, galactose and fructose are simple sugars and are the end products of digestion of carbohydrates.

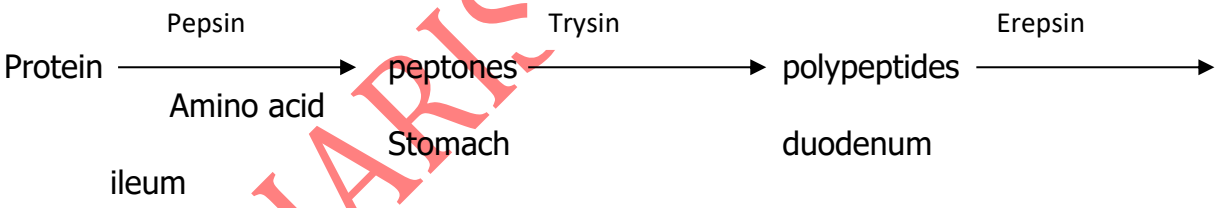
Large intestine / colon

They have mucous gland and there is no villi. No digestion occurs here except absorption of excess water which makes undigested food compact. The undigested food is stored in the rectum temporarily before it is egested out through the anus.
In man, the alimentary canal lacks a caecum with the result that cellulose cannot be digested. However, it is important that man includes plant material in his diet as this

gives bulk to the food and helps it to pass through the alimentary canal. Food that serves this purpose is referred to as roughage.
The large intestine ends at a point called the appendix (finger-like). In man, the appendix is often a cause of great inconvenience and pain as hard particles may collect in it and cause it to become infected and inflamed. This condition is known as appendicitis. Appendix is a vestigial organ. It is removed by appendicetomy.

Absorption of digested food

Absorption takes place in the small intestine whose surface area is increased by numerous finger-like villi (singular:villus). The villi contains smooth muscle enabling them to contract and relax, thus bringing them into contact with newly digested food.
Glucose and amino acids are absorbed by a combination of diffusion and active transport across the epithelial lining of the villi into the capillaries beneath. These capillaries drain into the hepatic portal vein where the digested food is conveyed to the liver.
Fatty acids and glycerol are absorbed into the epithelial cells lining the villi and there resynthesized into neutral fat which is shed into the lymph vessels of the villi as a white emulsion of minute globules. This gives the lymph vessels a milky appearance, for which reason they are known as lacteals. The lymphatic system opens into the veins from where fat finds its way into the blood.
The villi increases the absorptive area of the small intestine because of the finger-like projections. Epithelial cells are folded into micro villi to further increase the surface area for absorption, the villi are in constant keeping them in touch with digested food; villi are highly supplied with blood vessels for transport of sugar and amino acids; there is presence of lacteal duct for absorption of fatty acids and glycerol; villi passes thin epithelial linings for easy diffusion of digested food.



This is how the villi is adapted to its functions for absorptions of digested food. Inorganic salts, vitamins and water are also absorbed in the small intestine.

Absorption of Digested Food

In each villus, there is a blind lymphatic tube called lacteal which is surrounded by network of blood capillaries. The lymph in the lacteals transport carboxylic acid and glycerol which will combine to form fats again in the lacteal. The lymphatic vessels eventually empty their content into the blood vessels near the heart.
All the digested food substances are brought by the blood stream to the hepatic portal vein which runs from the small intestine to the liver.

Liver

Bile is stored in the gall bladder
Bile is produced in the liver, but liver has other function which are as follows:

i. Stores glycogen / converts glycogen to glucose
ii. Deamination of protein in the body; Deamination is the breakdown of excess amino acid into carbohydrate and amino groups in the liver. The amino group is converted into urea which are less harmful to the body

while carbohydrate is converted to glycogen and stored in the liver. The pancreas is the largest gland in the large organ in the body.

iii. Manufactures bile
iv. Formation of fibrinogen / heparin / prothrombin for blood clotting
v. Produces heat for maintenance of constant body temperature
vi. Stores vitamins A/D/B/B_{12}
vii. Stores iron/copper/ potassium
viii. Stores blood
ix. Formation of erythrocytes in the liver of foetus
x. Detoxification / detoxication
xi. Destroys worn out red blood cells
xii. It forms cholesterol (cholesterol is blood fat)

How the level of sugar in the mammalian blood is regulated

The liver controls the blood glucose level by converting excess glucose to glycogen. The process is stimulated by the hormone insulin which is secreted by the pancreas. When the blood glucose level falls below normal, the pancreas secretes glucagon that stimulates the conversion of glycogen into glucose which is released into the blood.

How the villi is adapted to carry out its function of absorption of digested food

i. The villi has the presence of fingerlike projections which increases the absorptive surface of the small intestine.
ii. Presence of epithelial cells which are folded to micro villi to increase the surface area for absorption of digested food
iii. The villi are in constant motion keeping them in touch with digested food
iv. The villi are highly vascularized for transportation of amino acid, glucose vitamins
v. These is presence of lacteal duct for the absorption of fatty acid and glycerol
vi. The villi have thin epithelial lining for easy diffusion of digested food.

The pancreas is the largest gland. The liver is the largest organ

low blood sugar - hypoglycemia

high blood sugar - hyperglycemia

Diseases of the liver

i. Jaundice
ii. Hepatitis
iii. Cancer of the liver (caused by gallstone)
iv. Liver cirrhosis
v. Gall stone

Disorder of alimentary canal in human

i. Cancer of the liver
ii. Ulcer
iii. Indigestion
iv. Cholera
v. Constipation
vi. Gall stone
vii. Dysentery
viii. Diarrhoea

ix. Gastroenteritis

Diagram of the longitudinal section of a villus

Excess glucose is converted to glycogen and stored in the liver and muscles. Excess amino acids are never store but converted into urea (through the process of deamination) by the liver and excreted by the kidney. The remaining parts are changed to glucose, glycogen or fats. Excess fats are stored in fat cells which group together to form adipose tissue, found under the skin, abdomen and buttocks.

Digestive System of Planaria

Planaria is a free living flat and small worm. The digestive system is made up of
(i)Ventrally placed mouth
(ii) Muscular pharynx
The intestine has 3 main branches i.e. one anterior and two posterior giving rise to what is known as extensive laterial diverticula and this forms the gastrovascular cavity. Inside the gastrovascular cavity, we have phagocytic cells, glandular storage cells and gland cells.
Planarians are carnivorous. They feed on small animals like crustaceans, rotifers etc. digestion is mostly intracellular and the digested food is distributed by diffusion to all parts of the body by gastrovascular cavity. The extensive branching of the gastrovascular cavity all over the body gives it a large absorptive cavity.

Drawing of the digestive system of planaria

Alimentary system of the earthworm
Lumbricus spp

The digestive system begins with a mouth and ends in the anus. It is divided into specialized compartment i.e. mouth, pharynx, oesphagus, crop, gizzard and intestine. It feeds on decaying vegetable or humus. It is found in moist soil, wet soil, damp soil, wet farmlands.

The food is ingested through the mouth i.e. the mouth is for feeding. It then passes through the pharynx. The pharynx secretes mucus or protein digesting enzymes and it also contracts to force the food through the oesophagus.

The food enters the crop, after leaving the oesophagus. The crop acts as a temporary storage of food. Then the food leaves the crop and proceeds into the gizzard which has a muscular wall where the food is grinded. The grinded food suspended in water passes into a long straight intestine where absorption takes place.

The faeces (worm cast) pass through the anus

The significance of the straight intestine in earthworm makes absorption of food to be inefficient

Drawing of the alimentary canal of the earthworm

The mouth of the earthworm is overhung by a fleshy liplike structure called prostomium. Glandular cells are found in the pharynx and they secrete mucus and protein digesting enzymes starting digestion of protein. The oesophagus contains glands that secrete calcium trioxocarbon (IV) oxide that remove excess calcium from food. in the intestine digestion and absorption of digested food occurs. The rear portion of the intestine absorbs some of the water involved in the digestion and the indigestible material are removed from the body through the anus as cast.

<u>Alimentary system of the grasshopper</u>

The alimentary system of an insect has 3 main parts

1. The fore gut: consisting of the mouth cavity, pharynx, oesophagus, crop and gizzard.
2. The mid gut:
3. Hind gut: intestine (ileum, colon, rectum and anus

The grasshopper has biting and chewing mouth parts which it uses to cut and crush the leaves. Saliva from the salivary gland helps the soften the leaves and then it passes through the oesophagus into the crop (temporary storage of food) and then into the gizzard where the food is further broken into smaller pieces.

At the junction of the fore gut are finger like projections called caeca (singular: caecum). These secretes enzymes rich digestive juices into the mid gut (mesenteron). Digestion and absorption of food occurs here.

In the hind gut, absorption of water occurs. Water conservation is important in insects only solid faecal pellets in stored in the rectum it is expelled through the anus.

The body waste is also emptied into the hind gut through the opening of a collection of narrow tubules called malpighian tubules (i.e for excretion). These are found at the junction of the mid gut and hind gut.

In the grasshopper, the salivary gland secretes digestive enzyme known as amylase which starts the digestion of starch food. The midgut consists of 6 mesenteric / digestive Caeca. The Caeca opens into the mid gut and secretes 3 types of digestive juices which contain 3 types of enzymes that complete the digestion of carbohydrate, protein and fat. Digestion and absorption takes place in the midgut. The hind gut consists of small intestine, retum and anus and between the midgut and the hindgut, we have the malpighian tubules which excretes

nitrogenous waste as uric acid. The rectum absorbs water from the faeces and then lets the dry faeces pass out through the anus.

Drawing of alimentary system of the Grasshopper/Cockroach

Alimentary system of birds

Birds are vertebrates belonging to the phylum Chordata. The alimentary system of the bird is therefore more advanced and more similar to that of a mammal. The jaws are modified into horny beak for picking and pecking seeds. Although birds do not have teeth, they have the mechanism for grinding up the food swallowed before it is digested. They have a tongue to facilitate swallowing

The alimentary canal of the bird consist of the following:

Pharynx, Oesophagus, Crop, Proventriculus, Gizzard, Intestine, Anus, Cloaca.

Birds swallow their food whole and store it in the crop and later pass it to the Proventriculus and then onto the gizzard (a strong muscular bag). The strong wall of the gizzard and the small stones often swallowed by the bird help in grinding up the food. The gizzard also contain gastric juice which also help in churning the food. Function of the gizzard is for grinding of food.

Digestion is completed in the small intestine by the action of the pancreatic juice and intestinal secretions. Absorption also takes place here. Most of the water is reabsorbed in the rectum. Solid waste is egested through the anus into the cloaca and out of the body. Body waste from the kidney, eggs and sperms also leaves the body through the cloaca.

In the proventricus (true stomach), there is secretion of gastric juice which contains protein digestive enzymes and dilute Hydrochloric acid

Adaptation of Gizzard

(i)Walls are thick, strong and muscular for grinding food

(ii)Presence of small stones swallowed by the bird which help in the grinding of the food into small particles.

The duodenum is the upper part of the small intestine. Bile emulsifies fats and oils while pancreatic juice contains amylase, trypsin and lipase which digest carbohydrates, proteins and fats respectively.

Digestion of all classes of food is completed in the lower part of the small intestine by intestinal enzymes. Absorption of digested food also occurs here.

Drawing of alimentary system of the bird

Similarities between the alimentary canals of birds and cockroaches

1. They both have caecum
2. They both have crop
3. They both have midgut
4. They both have muscular gizzards
5. They both have narrow oesophagus.

Differences between the alimentary canals of birds and cockroaches

	Birds	Cockroaches
1	Mouth modified into a beak	Mouth modified into labrum, mandibles and maxillae
2	Tongue present in the mouth	Tongue absent in the mouth
3	Pancreas present	Pancreas absent
4.	Hind gut ends in cloaca	Hind gut ends in anus
5.	Malpighian tubules absent	Malpighian tubules present
6.	Liver present	Liver absent

Lesson Two

FEEDING HABIT AND DENTITION

The principal mode of feeding for animals is by ingestion i.e. the taking in and digestion of bulk food. Animals may be

Feeding habits

1. Herbivores e.g grass, rabbits etc in which case, they obtain high energy compounds by eating plants. tilapia and carps.
2. Carnivores e.g dogs, lions etc. animals that eat flesh e.g. tiger fish
3. Omnivores e.g man need plant and animal materials to survive. Generally herbivores have long digestive tracts, carnivores, short tracts and omnivores tracts of intermediate length. e.g Man and pig
4. Scavengers: feed on dead organisms e.g. Vultures, earthworm

HERBIVORES

Plant matter contains a lot of cellulose which has to be broken down before it can be absorbed. Rabbit cannot make cellulase (enzyme digesting cellulose) instead, it has cellulose producing bacteria in its gut. This enables the rabbit to digest the cellulose in its food to glucose (symbiotic relationship)

The bacteria are found in the caecum. The problem that arrives during the digestion of food in the rabbit is that by the time cellulose digestion is complete, the contents would have moved past the small intestine where absorption takes place. The food passes out as soft, mucus-covered pellets. The rabbit quickly eats the pellets and the glucose they contain is absorbed in the small intestine. The intestine of herbivores is long because the food needs a longer time to digest.

Herbivores generally have three (3) adaptations that enables them to digest cellulose. They are;

1. Presence of very long intestine to increase the surface for digestion and absorption.
2. Presence of caecum and appendix for harbouring cellulase-producing bacteria. Caecum is located at the point where the small intestine joins the large intestine.
3. Special kind of stomach

RUMEN, RETICULUM, OMASUM AND ABOMASUM

Herbivores like cows goats etc. are called **ruminants**. They have a special stomach with four (4) chambers. Rumen is the first and longest stomach

When a cow eats grass it swallows it straight without chewing. It then passes to the rumen where it is churned up and mixed with bacteria and then it moves to the second stomach. When the animal is resting, the unchewed grass is passed back to the mouth (regurgitated) where it is chewed properly (cud chewing).

When swallowed for the 2nd time, the chewed cud goes straight to the other three chambers in the stomach and to the small intestine for further digestion and absorption of glucose, which is the end product of cellulose digestion.

Carnivores

Carnivores are adapted for catching prey: these adaption can be; high speed locomotion and dagger-like canine teeth in the great cats, sucker-bearing tentacles in octopuses an squids etc.

Chewing is carried out by the mandibles in carnivorous arthropods. Meat does not have non-digestible parts and can be acted upon directly by enzymes. So, the alimentary canal of carnivores are relatively short.

Omnivores

Omnivores (e.g man) have teeth that are structurally and functionally intermediate between those of the herbivores and carnivores and the alimentary canal of omnivores is intermediate between those of carnivores and herbivores.

Each particular feeding habit is associated with a particular set of dentition or arrangement of teeth in the upper and lower jaws.

Dentition

Dentition is the number and arrangement of teeth present in the mouth of an animal. There are two (2) types of dentition.

i. Homodont: Teeth of the same shape and size e.g. fish, reptiles
ii. Heterodont: Teeth of different sizes, shape and functions e.g. mammals

Types of teeth

We have 4 types of teeth in mammals

i. Incisors
ii. Canines
iii. Premolars
iv. Molars

Incisors: The front teeth, it is chisel-shaped and it is for biting and cutting of food

Canines: long pointed and conical with one root. They are for tearing of flesh e.g. flesh from bone.

Premolars: The top have 2-3 ridges (cusps) which are flat with broad surfaces for grinding food. They have more than one root.

Molars: possess broad surfaces with cusps which are used for grinding and chewing food. They also have more than one root

Dental formula

This is the formula which represents the number, kinds and arrangement of teeth

i= incisors

c= canines

p^m = premolars

m = molars

Types of teeth

Herbivores (e.g. rabbit)

i $\frac{2}{1}$, c $\frac{0}{0}$, p^m $\frac{3}{2}$, m $\frac{3}{3}$ = 14 X 2 = 28

carnivore (e.g. dog)

i $\frac{3}{3}$, c $\frac{1}{1}$, p^m $\frac{4}{4}$, m $\frac{2}{3}$ = 21 X 2 = 42

Omnivore (e.g man)

i $\frac{2}{2}$, c $\frac{1}{1}$, p^m $\frac{2}{2}$, m $\frac{3}{3}$ = 16 X 2 = 32

Drawing of the longitudinal section of a tooth

Adaptation of teeth in Carnivore to its mode of feeding

i. Possess pointed chisel-like and sharp incisors which is used for catching and holding prey or for prehension
ii. Canines are long, pointed and curved (for attacking and holding prey) and also for tearing flesh from bone.
iii. Presence of carnassials teeth (last upper pre-molar and first lower molar) which are large and used for tearing flesh from bones.
iv. The molars and premolars are narrow, but possess pointed strong cusps essential for grinding and crushing bones.

The carnivores dentition is adapted for hunting and flesh eating.

Adaptation of teeth in Herbivore

i. Possess a fairly sharp incisors which are adapted for cutting grass.
ii. Canines are absent leaving a toothless space between pre-molars and incisors which are known as diastema. Diastema allows for mixing of food.
iii. Premolars and molars are alike. They are both flat with tranverse ridges for grinding food substances.

Care of the teeth

i. Brush teeth with tooth brush and flouride toothpaste and clean water or use chewing stick at least twice daily to remove dirt.
ii. Eat less sugary foods to prevent tooth decay
iii. Visit the dentist regularly for teeth inspection.

iv. Rinse mouth with saline solution or clean water after meals and before going to bed.
v. Avoid picking the teeth with sharp pointed objects
vi. Avoid opening bottle taps with teeth
vii. Take a balanced diet or food rich in phosphorus and calcium
viii. Avoid taking too cold or too hot food / drink
ix. Exercise the teeth by chewing hard fibrous food

FEEDING MECHANISMS

A simple unicellular animal lacks an alimentary canal therefore digestion takes place inside the cell within a food vacuole. This is known as intracellular digestion.
A simple multicellular animal has a mouth for taking in food. The mouth opens into a sac-like gut cavity where food is digested. Digestion in the gut is said to be extracellular.

Feeding mechanisms in amoeba

Amoeba is found in muddy water at the bottom of ponds. It feeds on microscopic organisms or decayed food substances in the water. A mouth and alimentary canal is absent. When it comes in contact with its prey, the pseudopodium will grow towards the prey and it engulfs the food particles. Some water is also enclosed and the small cavity formed is called a food vacuole.
Enzymes from cytoplasm of the cell are secreted into the food vacuole to digest the food. The soluble products formed diffuse from the vacuole into cytoplasm. Digestion here is intracellular. This type of feeding in amoeba is called phyagocytosis. Paramecium also undergo intracellular type of digestion and the undigested waste products are passed out through the anal pore.

Feeding in hydra (Coelenterate)

Hydra is carnivores. When the prey gets to its tentacles, the tentacles produces stinging cells which inject poison into the prey and stun it. The tentacles coils around the prey and pushes it into the mouth. The whole prey passes into the gut cavity. Gland cells on the wall (endoderm) of the wall (endoderm) of the gut secrete digestive juice containing enzymes. Extracellular digestion of the prey occurs here and the food is broken into smaller particles. Digestion here is incomplete.
Gastrodermal cells engulf the half digested food particles so that digestion will be completed intracellularly in digestive vacuoles. Undigested remains are expelled through the mouth. This kind of digestive cavity with only one opening functioning both for ingestion and egestion is called gastrovascular cavity.

Filter feeders

This type of feeding is common in aquatic organisms that feeds on plankton. In order to trap this rich source of food, water is drawn towards the animal either through movement of its appendages or the action of cilia.
The water then passes through some kind of sieve found at the front end of the gut which filters off the food particles while the water flows out of the body. Examples of filter feeders are ducks, whales, flamingoes, oysters, mosquito larvae, copepods and crustaceans.
Mosquito larva for example has a pair of mouth parts with numerous bristles called feeding brushes with continuous revolving movement of these bristles, water

containing the suspended food particles are swept into its mouth. The food is strained and sent to the gut.

Fluid feeders

Two types of animals are groups as fluid feeders. They are:

i. Those that wallow in their food e.g. tapeworm in human intestine (they are called wallower).
ii. The suckers: they are mainly insects which feed by sucking fluids from plants (e.g. nectar) and animals (e.g. blood)

They make us of special mouth parts called proboscis e.g aphids, bees, mosquitoes etc.

Test for action of enzyme ptyalin

Procedure

1. Clean the mouth well with clean water to remove particles of food.
2. Collect some quantity of saliva
3. Put 1 ml of saliva in 2 tubes labelled A and B
4. Boil the saliva in A to serve as a control experiment
5. Add 1ml of 5% cooked starch solution into each tube and shake thoroughly to allow saliva and starch mix thoroughly.
6. Leave the test tubes to stand for about 10-15 mins
7. Test the contents of each test tube for
   (a) starch (iodine test)
   (b) reducing sugar (fehling's or benedict's test)

Observation

It will be observed that;

i. The contents of the test tube with untreated saliva, did not turn blue-black with iodine (i.e. starch absent) but gave a brick red precipate with fehling's solution or orange / yellow with benedict's solution; indicating the presence of reducing sugars.
ii. The contents of the test tube with boiled saliva turn blue-black with iodine (starch present) but no reaction with fehling's or benedict's solution; indicating absence of reducing sugars

We can see that ptyalin in saliva in the test tube which was not boiled charged the starch to reducing sugars while starch in the control does not charge because the ptyalin in saliva is inactivated by boiling.

Conclusion

Saliva contains an enzyme ptyalin which starts the digestion of carbohydrate in the mouth. It converts cooked starch to maltose sugar.

Structure of the teeth

The teeth is divided into three (3) parts:

Crown which projects above the gum

The root which lies embedded in the jaw bone

The neck

At the center of the tooth is the pulp cavity and it contain many blood vessels and nerves which are very sensitive to heat and cold and enclosing the pulp cavity is the dentine, covering the dentine is a white layer known as enamel. It is the hardest material made by animal it protects the pulp cavity and dentine within.

Enamel is not present in root region but a thin layer known as cement covers the dentine, inside the root region the cement is surrounded by periodontal membrane and fix the tooth to the jawbone.

Modifications and Mechanisms of Feeding in some Animals

There are five Modifications and Mechanisms of Feeding associated with some organisms feeding mechanisms include:

1. Absorbing mechanisms e.g. Tape worm
   The tapeworm is an endoparasite which carries out parasitic feeding on its host i.e, the man

Drawing of the head and mouth part of tapeworm

It has no mouth but absorbs digested food from the intestine of its host. The body of the tape worm is modified and adapted for parasitic feeding as follows:

(i) The alimentary canal is absent, hence food is absorbed through its entire body surface.
(ii) The tapeworm has hooks and suckers which are used for attachment to the intestine of the host to avoid dislodgement.
(iii) The body has thick cuticle which resists digestive enzymes of the host.
(iv) The flat body surface of the tapeworm provides a large surface area for the absorption of already digested food.

(v) The entire body surface is used also for the absorption of food.

2. Biting and chewing mechanism e.g. grasshopper or cockroach
   The grasshopper or cockroach has mouth parts adapted for biting and chewing. These insects have four different mouth parts which are modified and adapted for biting or chewing food. These mouth parts are

Drawing of the head and mouth part of grasshopper

(i) Labium or upper lip: The grasshopper has labrum or upper lip which prevents the food from falling off the mouth.
(ii) Mandibles: It possesses a pair of mandibles which are heavy toothed and jaw-like structures used for cutting and chewing food materials.
(iii) Maxillae: The grasshopper also has a pair of maxillae which is also a biting blade. This breaks down the food which the mandibles has chewed into smaller particles
(iv) Labium: The labium (lower lip) prevents the wastage of food from the mouth.

3. Sucking mechanisms

There are these popular organisms which exhibit sucking mechanism. These are mosquito, butterfly and housefly. These insect have different modifications of mouth parts adapted for feeding on food through the mechanism of sucking.

Drawing of the head and mouth part of female mosquito

(i) The mosquito possesses a piercing mouth parts called the proboscis used for sucking the blood of man and animals.
(ii) The mouth parts altogether form a string stylet capable of penetrating the skin to suck blood.
(iii) The stylet except the labium is sharp and pointed to case penetration into the skin
(iv) The mouth can produce saliva to prevent clothing of blood while it is being sucked in.
(v) It has the ability to fold back the labium easily so as to allow the stylet to perform its work of penetration of the skim to suck blood.

BUTTERFLY

The butterfly feeds on liquid food like nectars of flowers. It has its mouth parts modified for sucking in the following ways.

(i) It possesses a long slender and coiled proboscis used for sucking nectars of flowers.
(ii) The insect is capable of recoiling the long proboscis and/or its head when not in use.
(iii) There is the non-functioning of the other mouth parts due to the type of food taken by the insect.

HOUSEFLY

The housefly feeds on liquid food materials. It has mouth parts modified for sucking in the following ways:

(i) The housefly possesses enlarged labella which are sucking structures for liquid food
(ii) The housefly has the ability to feed on solid food e.g sugar by pouring out its saliva to change the food to a liquid state.

(iii) It has a sucking mechanism called sponging in which the mouth is placed on the liquid food and it will start to rush into the mouth.

(iv) The labella has fine channels which aid rapid absorption of liquid food into the mouth.

Drawing of the head and mouth part of the butterfly

Drawing of the head and mouth part of the Housefly

4. Grinding mechanisms: Grinding mechanisms is common among mammals e.g. man, cattle, sheep ad goat. These animals are capable of grinding the food before swallowing. This grinding is aided by the presence of hard and strong teeth made up of enamel and dentine.
   The animals are adapted to the grinding mechanism by the following features:
   (i) They possess different sets of teeth to grind food.
   (ii) The teeth are hard and string to withstand biting and chewing or grinding and cracking of food.

(iii) They possess incissors which are sharp with flat edges used for cutting off bits of food.
(iv) Animals have pointed canine teeth which are used for tearing food.
(v) There is presence of premolars and molars with undulating and wide surfaces area for grinding of food.
(vi) The absence of front teeth in sheep is a special adaptation as it helps to grip the grasses during feeding by the animals

5. Trapping and absorbing mechanisms
Trapping and absorbing mechanisms are common among the insectivorous or carnivorous plant such as bladderwort and sundew. Bladderwort and sundew have structures which enables them to adapt to this mode of feeding.
(i) Sundew for example traps insects by undergrowing nastic movement in responses to touch from the body of the insects
(ii) The sundew leaf has long hairs which carry digestive glands
(iii) Insect on landing on these hairs causes other hairs to curl over the insect and cover it.
(iv) The sundew is capable of secreting a fluid rich in enzyme to digest the insect externally.
(v) The protein so synthesized is easily absorbed by the carnivorous plant into its body.

Drawing of the head and mouth part of the bladderwort

Drawing of the head and mouth part of the Sundew

Lesson Three

RESPIRATORY SYSTEM

Respiration is a metabolic process that take place in a living cell or in living organism by which glucose is broken down in the absence or presence of oxygen in order to release energy for life activities and water and carbondioxide are also given out as by product.

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{enzyme}} 6CO_2 + 6H_20 + 38\ ATP$$

We have two phases of respiration

i. Internal respiration or tissue or cellular respiration
ii. External or gaseous exchange

Note: All chemical reactions leading to the release of energy from food together make up tissue respiration.

Respiration in man

In man, as in other mammals lungs is the main respiratory organ. The breathing system of man comprises- nose (nostrils), pharynx, larynx, trachea, bronchi, bronchioles, the lungs, thorax and diaphragm.

Atmospheric air enters through the nostrils to the trachea and through the pharynx and larynx. The trachea branches into two bronchi which enters the lungs. In the lungs each bronchus profusely divides into bronchioles terminated with tiny thin-walled cup shaped air sacs called alveoli. Each alveolus is surrounded by a dense network of blood capillaries where gaseous exchange takes place. (the trachea is the wind pipe.

Gaseous exchange (external respiration)

This is the breathing in of oxygen and breathing out of carbondioxide and water vapour. Gaseous exchange takes place in the respiratory surface.

Animals are more active than plants and they are also able to move about freely. Being so much more active, they need more energy than plants do. Hence, they have a higher rate of respiration than plants.
The gas exchange organs or structures and surfaces and the mitochondria in every living cell collectively form the respiratory system of an organism.
Gas enters and leaves the cells of an organism by diffusion, therefore the gases must dissolve in water first before they can diffuse across cell membrane. Hence respiratory surfaces must have gaseous exchange surface that are bathed in water.
The mitochondria is concerned with production of energy and not with gaseous exchange (externally).

Gas exchange organs (structures) of organisms

S/N	Organism	Gas exchange organ/surfaces
i	Unicellular organisms e.g amoeba, euglena, simple multicellular plants like sponges, spirogyra etc	Entire body surface by simple diffusion
ii	Hydra and flat worm	Cell membrane (by diffusion)
iii	Earthworm	Moist skin
iv	Crustacean e.g. crab, prawn, lobster	Gills
v	Insects e.g. cockroach	Tracheal system (which consists of breathing system of air tubes; trachea and tracheoles which open to the exterior through spiracles
vi	Spider	Lungbook
vii	Mosquito larva and pupa	Breathing trumpets or siphon
viii	Fish e.g. Tilapia, mud fish etc	Gills
ix	Tadpole	Gills
x	Amphibians e.g. toad, frog	Lungs (pulmonary) , skin (cutaneous) and mouth (buccal cavity)
xi	Reptiles	Lungs
xii	Birds	Lungs
xiii	Mammals	Lungs
xiv	Flowering plants	Stomata (leaves) Lenticels (stems) Root hairs

Characteristics of gas exchange organs (surfaces)

i. The surface area to volume ratio are large (i.e. to increase the quantity of gases that could be exchanged at any given time)
ii. They have thin walls for easy diffusion
iii. They are always moist for easy diffusion
iv. They must be closely linked to transport system for easy transportation of gases.
v. It must be highly vascularised in order to aid transportation of different gases.

The mitochondrion is the organelle for respiration in cells

Conditions necessary for respiration

(1) Respiratory organ/surface
(2) Transportation medium (blood vessels)
(3) Respiratory medium
(4) Ventilation
(5) Respiratory surface

Ventilation: This is the movement of water or air in one direction over the respiratory surface.

Gaseous exchange in fish

The fish is an example of an aquatic animal that uses the gills as the respiratory organ. It cannot use the body surface because it is a large, multicellular animal with a small surface area to volume ratio and also because the scales makes its skin water proof.

The gills chambers in fishes are covered on the two sides by opercula (singular operculum) or gill covers. The space between two gills is known as the gill slit.

Each gill consist of 3 parts

i. The gill arch: main body of the gill and it is curved in shape. It is the middle part of the gill.
ii. The gill filaments: Numerous pale pink projections which are attached to the rear end of the gill arch. They are well supplied with blood capillaries.

Gills rakers: short pointed projections attached to the front of the gill arch. They do not take part in gaseous exchange. They act as food strainers and prevent food from entering the gill chambers.

Mechanism of breathing in the fish

a. The operculum is closed, the mouth is opened (inspiration)
b. The floor of the mouth is lowered causing the volume of water to increase and the pressure inside the mouth lowered.
c. The water flows in from outside into the mouth, in response to the lower pressure inside the mouth.
d. The mouth is closed and the floor of the mouth raised, thus increasing the pressure inside the mouth
e. The operculum is opened, water flows from the mouth through the gill slits, bathing the gill filaments and out flow through the gill cover or operculum (i.e. expiration)

The water is bathing the gill filaments which are richly supplied with blood capillaries, the oxygen dissolved in the water diffuses into the blood in the blood capillaries where carbondioxide diffuses out from the blood into the water and passes out through the operculum.

Drawing of a gill

Gaseous exchange in toad

The toad is an amphibian gaseous exchange takes place in four ways namely:

i. Gills – (external gills at early tadpole stage which disappears to be replaced with internal gills at the next tadpole stage)
ii. Cutaneous (skin) – use of skin whenever in water
iii. Buccal cavity – exchange of gas in the mouth richly supplied with blood vessels
iv. Pulmonary or lungs

The adult toad uses 3 organs for gaseous exchange

1. Buccal or Mouth: The buccal cavity of the toad or frog is used as a respiratory organ because:
   (a) It has a large surface area to volume ratio for easy exchange of gases.
   (b) It has a thin membrane for easy diffusion of gases
   (c) It is highly vscularized (i.e supplied with blood capillaries) for easy transportation of diffused gases.

For toad to take in oxygen, the mouth is closed, nostrils opened and the floor of the buccal cavity lowers. This creates a low pressure inside the buccal cavity making air to be drawn in from outside through the nostrils. After this, the nostrils and glottis then closes. Gaseous exchange then takes place in the buccal cavity between the blood in the capillaries of the mouth and the inhaled air.

To remove the carbon(iv) oxide from the body, the toad will raise the floor of the buccal cavity leading to the increase in the air pressure inside the buccal cavity. This will make the nostrils open and air containing carbondioxide is forced out into the environment.

2. Skin or Cutaneous: The skin also serves as an efficient respiratory organ in toad because it has a large surface area, thin membrane, moist and highly vascularised. Oxygen that is present in water and on land can therefore diffuse directly through the entire body covering into the blood of the capillaries from where it is transported to cells and tissues of the body and carbondioxide from the cells and tissues of the body also diffuse out from the blood into capillaries through the skin of the body.
3. Lung (Pulmonary): The adult toad carries out gaseous exchange with its lung on land. The mechanism is similar to buccal and it is as follows:

When the toad draws in air, the mouth is closed, nostrils are opened and the floor of the buccal cavity is lowered. This creates a low air pressure within the buccal cavity which makes air containing oxygen to be drawn in from outside through the nostrils. After this, the nostrils are closed while the glottis is open and air is forced into the lungs through the glottis, larynx, and finally to the lungs. Oxygen then diffuses into the capillaries of the aveoli while carbondioxide diffuses out from the blood capillaries into the lungs from where it is sent out. The air containing carbondioxide is drawn out from the lungs into the glottis by lowering of the buccal cavity while the nostrils are closed. After this, the floor of the mouth is raised several times while air is pumped out of the lungs and finally forced out through the nostrils.

Tracheal system in insects

The abdomens of insects are perforated with a pair of pore called spiracle per segment. Each spiracle guarded by hair opens into longitudinal and transverse

trachea. The transverse tracheas is further divided into tracheoles containing fluid and allow the exchange of gases.

pathway: Spiracle →trachea →tracheoles = Body cells

Drawing of the structure of the trachea system

Mechanism of breathing in insects

Taking the grasshopper as an example, it performs breathing movement by compressing its body dorsoventrally, When it compresses its body, it becomes flatten than before and air is expelled from the tracheae through the spiracles (expiration). When it relaxes its body, air enters into the tracheae (inspiration). These breathing movement are visible to the naked eyes in large insects. When air enters the trachea and tracheoles, oxygen in the air dissolves in the body fluid and diffuses into the cells of the body. Carbondioxide diffuses out from the body fluid into the air in the tracheoles and passes out of the body through the spiracles.

Respiration in mammals

Most vertebrates including birds, lizards and mammals use the lungs as their respiratory organs where gaseous exchange takes place.

The lungs is a pair of reddish, elastic organ on each side of the heart of a mammal located within the thoracic cavity of the body. The thorax is supported by a bony framework and consist of the thoracic cavity. There is a dome-shaped muscular wall at the bottom of the thoracic cavity called the diaphragm which separates the thoracic cavity from the abdominal cavity.

The ribs are attached to the backbone and the breastbone or sternum thus forming a bony cage. They are connected to one another by muscles known as intercoastal muscles. Inside the thoracic cavity lies the heart and the lungs.

Mammalian Respiratory System

We can breathe in air through our nostrils and mouth but it is better to breathe in air through the nostrils due to the following reasons:

i. The structure of the nostrils allows air to become warm and mosit and filtered before it gets to the lungs.
ii. There are presence of small thin bones inside the nostrils called turbinal bones. These bones are covered with a thin layer cells and some of these cells make a liquid containing mucus which evaporates into the air.
iii. There is presence of cilia in the nostrils and they are always moving so that they filter off bacteria and particles of dust in them and in the mucus.

These cilia are also found in the trachea and bronchi where they sweep the mucus containing bacteria and dust off to the back of the throat so that they will not block the trachea. Cilia in the nostril also sweep mucus into the oesophagus where it can be swallowed.

	Gas	Inspired Air (Breathing in)	Expired Air (Breathing out)	Reasons for differences
1.	Oxygen	21%	16%	Oxygen is absorbed across respiratory surface then used by cells in respiration
2.	Carbon (iv) oxide	0.03%	4%	Carbondioxide is made by cells as a waste product of metabolism during respiration and is released across the respiratory surface.
3.	Noble gases	1%	1%	Not used by the cells
4	Nitrogen	78%	78%	Not used by the cells
5.	Water vapour	Variable	Always high	Respiratory surface must be kept moist and some of this moisture evaporates and is lost as air when we breathe out.
6.		Variable	Always high	Air is warm as it passes through respiratory passages

Respiration System of man

In man, as in other mammals lungs is the main respiratory organ. The breathing system of man comprises – (nose) nostrils, pharynx, larynx, trachea, bronchi, bronchioles, the lungs (diaphragm).

Atmospheric air enters through the nostrils to the trachea and through the pharynx and larynx. The trachea branches into two bronchi which enters the lungs. In the lungs each bronchus profusely divides into bronchioles terminated with tiny thin-walled cup shaped air sacs called alveoli. Each alveolus is surrounded by a dense network of blood capillaries where gaseous exchange takes place.

Diagram of the respiratory system of man

Note: reptiles and birds do not have diaphragm, breathing is brought about by contractions of the muscles of chest and abdomen.
The nostrils lead into the posterior position of the mouth cavity called pharynx and this leads into the voice box or larynx. The larynx leads into the windpipe or trachea. A flat piece of tissue, the epiglottis covers the entrance to the larynx to prevent food particles from entering into the larynx and trachea when food is swallowed into the oesophagus which lies just behind the trachea.
Both the trachea and bronchi have rings of cartilage which strengthen them and prevent them from collapsing when the pressure of air inside is low.
The bronchioles lead to numerous air sacs called alveoli. The alveoli are richly supplied with blood capillaries and are sites or surface where gaseous exchange takes place. The lungs are located in the thoracic cavity.
The structures of lungs
It is soft and fluffy, bright red in colour and the surface is folded.

Mechanism of breathing using the lungs
There are 2 phases in the breathing process, they are; inspiration and expiration
Process in inspiration (inhalation)
(Breathing in of oxygen)

1. Diaphragm contracts and flattens out
2. Intercostals muscles contract, ribs are thus raised and move upwards and outward.
3. Sternum moves forward.
4. Volume of the thoracic cavity increases and pressure in the lungs decreases.
5. Air from the atmosphere (outside) rushes in through the nostrils, trachea, bronchi, bronchioles and fills the alveoli where gaseous exchange occurs.

Process of expiration (exhalation) breathing out of carbondioxide

1. Diaphragm relaxes and returns to its dome-shape
2. Intercoastal muscles relaxes and ribs are lowered and move downward and inward
3. Sternum moves backwards
4. Volume of the thoracic cavity decreases and pressure in lungs is increased
5. Air is expelled from the lungs through the bronchioles, brochi, trachea moves out through the nostrils into the atmosphere.

Inside each lung oxygen in the inhaled air in the alveoli diffuses into blood capillaries surrounding the alveoli. Oxygen is carried by the red blood cells in form of oxyhaemoglobin to all body cells where it is used for respiration.
At all times, fresh air is taken into the lungs of mammals, while stale or used air is sent out. This process is called ventilation. Mammals breathe to renew the air in their lungs. Our lungs do not become completely empty after our normal exhalation, some air still remains in our lungs and this is known as the residual air.
The air that moves out of the lungs each time a normal inspiration or expiration occurs is known as the tidal air.

Diseases of the respiratory tract

1. Bronchitis
2. Lung cancer
3. Emphysema

4. Asthma
5. Pneumonia
6. Tuberculosis
7. Common cold and catarrh
8. Silicosis
9. Hay fever

Breathing at high altitude and deep in the sea

At high altitude, the air pressure is less hence the amount of oxygen inhaled is less. People on high mountains get used to low oxygen content over the years and such people have red blood cells count to increase the transportation of oxygen to the body cells.

People who climb high mountains as well as sea divers wear oxygen mask and cyinder to supply them extra oxygen.

Comparism of Breathing Mechanism in a Working Model With Mammalian Lungs

A breathing mechanism in an experimental setup can be compared with the working of a mammalian heart.

The figure below illustrates a working model of the respiratory system or breathing mechanism of a mammal. the labeled diagrams illustrate the structures in mammals in the following ways:

i. Glass tube represents the trachea
ii. Bell jar represents the thoracic cavity
iii. The balloons represents the lungs
iv. The rubber sheet represents the diaphragm
v. Letter A represents bronchus
vi. Letter B represents thoracic chamber

The process illustrated in diagram I is inspiration or inhalation while that of diagram II represents expiration or exhalation.

Diagram of the process of inhalation and exhalation

During breathing out or exhalation, not all the air is removed from the lungs. The air left inside the lungs during breathing out is residual air.
Importance of Residual Air

i. Air is left inside the lungs so that the lungs does not collapse
ii. Air is always left inside the lungs so that more oxygen can be removed or diffused into the blood stream.

Tidal air: This is the air that is exchanged with each breath.

Causes of Oxygen debt

i. Strenuous exercises leading to shortage of oxygen in muscle cells
ii. Lungs unable to meet the demand of oxygen in the cells of the muscles
iii. Cells of the muscles have to respire

Respiratory Quotient (RQ)

During aerobic respiration, oxygen is used up and carbon (iv) oxide is produced as a by-product. RQ is the amount of carbon(iv) oxide produced divided by the amount of oxygen consumed of a particular food at a particular time. RQ reveals what type of food is being oxidized and the type of metabolism that is going on in the organism

$$RQ=\frac{molecules\ of\ CO_2\ produced\ in\ respiration}{molecules\ of\ O_2\ used}$$

In human, RQ ranges from 0.70 -1.0. This indicates that fats and oils, proteins are also used for respiration.
NOTE: RQ greater that 1.0 indicates that the organism is short of oxygen and is respiring both aerobically and anaerobically and if the organism is respiring oils and fats RQ is less than 1.0 because more oxygen is needed.

Plants usually have RQ less than 1.0 because part of CO_2 produced during respiration is used up again for photosynthesis

Differences between Gaseous Exchange and Respiration

	Gaseous exchange/Breathing	Aerobic respiration
1.	There is no release of energy	There is release of energy
2.	Occurs outside the cell	Occurs inside the cell
3	Oxygen moves in and Carbondioxide moves out.	Oxygen is used to breakdown glucose
4.	Physical process	Chemical process
5.	Enzymes are not involved	Enzymes are involved.

Gaseous exchange in plant

Gas exchange in flowering plants is due to respiration and photosynthesis. The respiration and photosynthesis occur in the green parts of plant during the day. Carbondioxide for photosynthesis diffuses into the leaf through the stomata.
Photosynthesis occurs faster than respiration; therefore CO_2 released during respiration during the day is used for photosynthesis in green plant tissues some of the oxygen released during photosynthesis is used for respiration while excess diffuse out through stomata and lenticels.
Respiration continues at night while photosynthesis stops

There is more stomata on the lower surface of leaves to reduce transpiration

Gaseous exchange in the leaves of flowering plants

i. During darkness, oxygen from the atmosphere diffuses through the stomata into the air spaces of the mesophyll layer of the leaves.
ii. It dissolves in the moist surfaces of the cells
iii. And then diffuses into the mesophyll cells
iv. The carbon (iv) oxide produced from this cells diffuses out through the stomata.
v. During the day, oxygen diffuses out through the mesophyll to the atmosphere
vi. Carbon (iv) oxide from the atmosphere diffuses into the mesophyll cells

Gaseous exchange structures

1. Stomata: microscopic opening on the surfaces of the green aerial parts of the plant
2. Lenticels: Tiny openings on old stems and roots
3. Root hair : In young root

There is no special respiratory organ in plants. Sufficient atmosphere gas enters the plant through the stomata and lenticels. In submerged and lower plants, gaseous exchange is by diffusion.

Opening and closing of stomata

The guard cells surround each stomata containing chloroplast and carry out photosynthesis. The internal walls close to the stomata is thicker and more elastic than the outer side of the cell. During photosynthesis sugar is formed it increases the cell sap concentration which enters the guard cells by osmosis and becomes turgid. There is more expansion on the innerside of the guard cell. This causes the stomata to open. At night, sugar in guard cells reduces. The guard cells loose water to the surrounding tissues by osmosis and becomes flaccid and closed

Mechanism of opening and closing of the stomata

i. When the solute glucose concentration of the guard cell is high
ii. Water flows from the neighbouring epidermal cells into the guard cells by osmosis
iii. The volume and turgidity of the guard cells increase
iv. The thin outer walls of the guard cells stretch more than the thicker inner walls
v. Causing the stomata to open
vi. When the solute glucose concentration is low, water flows out of the guard cells by osmosis
vii. The volume and turgidity decreases causing the guard cells to become flaccid and the stomata pore is closed.

Diagram showing how the guard cells open and close a stoma

Differences between respiration and photosynthesis

S/N	Respiration	Photosynthesis
1	Organic matter is broken down (catabolic) (glucose)	Organic matter is synthesize (anabolic)
2	Oxygen is used up	Oxygen is produced
3	Energy is released in form of ATP	Energy in form of heat is absorbed and stored
4	Carbondioxide is released	Carbondioxide is used up
5	Water is released	Water is used up
6	All living things carry it out	Carried out by only green plants
7	Takes place in the mitochondrion	Takes place in the chloroplast
8	Occurs both day and night	Occurs in day time

Lesson Four

EXCRETION

Excretion is the removal of waste product of metabolism from the body or cells of a living organism.The common excretory products formed in the bodies of animals are water vapour, carbondioxide, mineral salts, nitrogenous compounds such as urea, uric acid and ammonium compounds.

Most of the waste products are products of body's metabolism and can be referred to as metabolites. The products excreted may also include poisonous materials taken in with food.

Some of the waste products like water can be given out by transpiration (in plants), diffusion or excretion through the body surface of organism.

Others are transported to special excretory organs to convert them to harmless products e.g excess amino acids cannot be store in the body. They are deaminated

to produce carbon fragments which are converted to carbohydrates and stored and also to nitrogenous fragments which give rise to (urea) ammonia (the most poisonous of metabolic by-products). These are then gotten rid of in a more organized way.
In aquatic animals, ammonia can be gotten rid of by diffusion but it is not possible in multicellular animals, so ammonia is converted to less toxic substances like urea and uric acid.
In certain cases, the waste products are stored away in harmless form and they are gotten rid of only when a part of or the whole organism dies and is decomposed.
The removal of undigested food in animals through the anus is egestion. Secretion is the production of useful substances such as enzymes and hormones by metabolic process.
Apart from excretion of waste products, excretory systems also help to maintain a constant internal environment which is known as homostasis.

Excretion in plants

The major excretory product in plants are:

i. Water produced during respiration
ii. Carbondioxide produced during respiration
iii. Oxygen released during photosynthesis

These substances are removed mainly by diffusion through the stomata in the leaves and lenticels in the stems and roots.
Other excretory products of plants that are of beneficial use to man are:

i. Anthocyanins produced from leaves and petals. It is used dyes
ii. Alkaloids: This is produced from barks, fruits and leaves of plants and is of importance in medicine.
iii. Tannins: This is obtained from cell sap, cell wall and most abundantly in dead tissues like bark and woody tissues of certain trees e.g. oaks, mangrove, conifers and it is used during tanning of leather.

Some oils are also produced as excretory products in plants. These include:

(a) camphor oil: Which is produced from camphor tree and is of importance in medicine and cosmetics
(b) Ginger oil: This is obtained from rhizome and is used as spices for beverages and food.
(c) Eucalyptus oil: Which is obtained from euralyptus tree and is of a valuable importance in medicine.

In certain plants e.g. tomatoes, potato, cabbage and a few grasses the excess water is also gotten rid of in a liquid form in addition to the process of transpiration. Droplets of water resembling dew-drops often form at the tips and margins of leaves. They enlarge and eventually drop off. This process is known as guttation. This occurs when too much water is absorbed by the roots of a plant and when transpiration does not rapidly enough to get rid of excess water.

Excretion in animals

Excretion in lower animals

In one celled organisms

These organisms use contractile vacuole and this is by simple diffusion through the cell membrane. The contractile vacuole is a small sac lined with unit membrane lying freely in the cytoplasm.

Since these organisms are aquatic (e.g. amoeba, paramecium, euglena etc) water constantly enters the cell through its selectively permeable membrane by osmosis. Excess water is then secreted into the contractile vacuole which expands and eventually discharges its contents to the outside.
During this process waste products are also eliminated. Carbondioxide and nitrogeneous waste diffuse out from where they are accumulated to the surrounding water. This mechanism is adequate for excretion of metabolic wastes since the surface area to volume ratio of the amoeba is large.
In flatworms
Flatworms can be parasitic or free living. They have a definite excretory system which consists of numerous flame cells or protonephridia
Each flame cell is shaped like a funnel with flagella around the mouth. The flagella beat continuously and thereby such the excretory products into the funnel. The excretory products such as ammonia, carbondioxide and water from the surrounding parenchymatous cells enter the flame cell by diffusion and these products are discharged through pure to the exterior.

Diagram of the Flame cell

The beating of the flagella or cilia helps to push water and excretory waste towards the intercellular duct.

<u>In earthworm, crustaceans and molluscs</u>
The body of the earthworm is segmented and each segment has a pair of tubes called nephridia. These are excretory organs of the earthworm (singular: Nephridium). The nephridium are in pairs in each segment. Each opens into coelom

cavity internally where it forms a wide mouth ciliated funnel (nephrostome) with which water is excreted. While it opens as a pore externally through which waste products are passed out. Unlike the flame cells, the nephridium opens at both ends while the flame cells open at one to the exterior.
Excess calcium is eliminated through the gut, in combination with carbondioxide. Excess water is removed from the body through the nephridia. The expelled water keeps the body of the worm moist. This is important since the eartworm require a moist body for effective respiration, so in the course of excretion, respiration is promoted.

Diagram of the structure of the Nephridium

The excretory organs in the crustaceans are the green glands which are very much like the nephridia. Each gland consists of four (4) parts:

(a) A small end sac
(b) Labyrinth
(c) Nephridial canal
(d) Urinary bladder

Excretion in insects

The excretory organs in insects are the malpighan tubules. They are found between the mid gut and the rectum. One end of each tubule opens into the gut while the other free end floats in the haemocoel.
Nitrogenous waste products and water which are discharged into the haemocoel are absorbed at the distal end of the malpighan tubule. The nitrogenous waste is converted to uric acid as it passes along the malpighan tubule towards the gut. A great deal of water is reabsorbed so that by the time the uric acid gets to the proximal end of the malpighian tubule it is converted to solid crystal. More water is

reabsorbed by the rectal gland and the urine which eventually leaves the body is concentrated and almost a dry solid.
Insects expel their urine along with faeces. The reaborption of water is necessary to facilitate the conservation of the water which enables insects to survive even in the hottest and driest place on earth.

Importance of excretion

1. Excretion removes excretory product that are harmful to the body.
2. Excretion helps to maintain water balance in the body
3. It helps to maintain salt balance in the body
4. Waste product when not remove can interfere with the normal metabolic activities of the body.

Diagram of Malpighian Tubule

Excretory organ	Main excretory product	Source	How they are excreted
Kidney	water, mineral salts, urea (nitrogenous wastes)	Body cells	Through urine
Liver	Bile pigment and cholesterol	Liver cells	Through intestine
Lungs	Carbondioxide, water vapour	Respiring cells	Through exhalation
Skin	water, a little urea	Body cells	Through sweat

Structure of the kidney
It is located at the dorsal wall of the abdominal cavity
The two bean shaped kidney are held in place by masses of fatty tissues. Kidney is an adrenal gland which is an endocrine gland.

The kidney removes unwanted nitrogenous substances e.g. urea and ammonium compounds. Each kidney is covered by a tough transparent membrane called the capsule. The outer edge of the kidney is convex while the inner edge is concave. At the concave edge lies a depression called Hilum from which a narrow tube, the ureter arises.
The hilum is also the point at which the renal artery enters the kidney and the renal vein leaves it. The renal artery, which originate from the dorsal aorta brings blood containing excretory products and oxygen to the kidney, while the renal vein drains filtered deoxygenated blood from the kidney to the posterior vena cava.
The ureter connects the kidney with an oval, transparent sac-like chamber called the urinary bladder situated at the base of the abdomen. The walls of the bladder are elastic. From the bladder, a narrow muscular tube called urethra continues downwards and opens to the outside as a small aperture.

Main functions of the kidney is

(i) Osmoregulation
(ii) urine formation (excretion) i.e removal of nitrogenous waste
(iii) Homeostasis / PH balance

Diagram of the longitudinal section of the mammalian kidney

A longitudinal section of a kidney shows that it consist of two distinct regions:

i. An outer cortex
ii. Inner medulla

Several thousands of fine narrow tubule called nephron cut cross both of these regions and open at the papillae of triangular shaped masses of tissues called pyramid. The pyramids opens into a funnel shaped cavity called the pelvis. The pelvis is continuous in the ureter. The kidney tissue consists of a vast number of blood capillaries which are branches of the renal artery and vein.

Diagram of the Longitudinal Section of Mammalian Nephron (urinary tubule)

Each urinary tubule consist of a malpighian body which is situated in the cortex and a convoluted tube. The malpighian body consists of a thin – walled cup-like chamber called the bowman's capsule into which blood capillaries or the glomerulus fits. The cillain the tubule helps to maintain the flow of urine in one direction.

Beyond the malpighian body each tubules make a characteristic u-shaped loop in the medulla. After which it re-enter the cortex, bend again and complete its curves in the medulla. The u-shaped loop is known as Henle's loop and throughout its curve it is closely connected with several network of blood capillaries.

The tubule joins the surrounding tubules to form collecting duct or tubules which eventually join up and open into the pelvis at the tip of the pyramid and then into the ureter. Henle's loop is found in the medulla.

Drawing of the excretory system of mammals

How the kidney performs its functions

The two major functions of the kidney are:

i. Removal of excretory product of /formation of urine
ii. Osmoregulation

(other functions have been mentioned earlier)

Blood containing glucose, mineral salt, urea, vitamins and other essential substances passes through the renal artery into each glomerulus in the kidney. The afferent arterioles that enters each glomerulus is wider than the efferent arteriole leaving it. Hence, it is under high blood pressure that blood and dissolved substances are filtered through the wall of each glomerulus into the bowman's capsule. This process is called ULTRAFILTRATION

The glomerulus filtrate contains all the constituent of the blood except the plasma protein and blood corpuscles. As the glomerulus filtrate passes through the proximal portion of the tubule and then through the Henle's loop, some water, sugar, aminoacids and salts which are useful to the body are re-absorbed into the blood capillaries. This is known as SELECTIVE RE-ABSORPTION.

The filtrate then moves into the distal part of the tubule. Here, large waste molecules are secreted into the tubules. If need be ions like hydrogen, potassium and hydrogencarbonate are secreted into the tubules to keep the osmotic concentration of the blood constant. The fluid that retains in the tubule is concentrated and is known as urine.

The process above is a summary of urine formation which we can involves mainly:

i. Ultrafiltration
ii. Selective re-absorption

Note: Re-absorption is an active process which requires much energy. The energy is obtained from tissue respiration. The filtered blood leaving the kidney through the renal vein contains less oxygen and glucose, but more carbondioxide as a result of tissue respiration and less nitrogenous wastes e.g. salt and water because of excretion.

Urine formation (function of kidney as an excretory organ)

i. Blood from the renal artery enters the bowman's capsule through the afferent arterioles at a high pressure.
ii. Ultrafiltration occurs in the bowman's capsule, the blood contains glucose, mineral salts, urea and other essential substances. These substances passes from the renal arteriole to the glumerulus of the kidney.
iii. High pressure in the glomerulus causes the filtration of small molecules of amino acids, salts, glucose, water and urea out of the blood plasma into the cavity of the bowman's capsule. The blood corpuscle and plasma protein do not pass through the glomerulus because they have large molecules size.
iv. The glomerular filtrate passes through the bowman's capsule into the proximal convoluted tubule where selective reabsorption of useful metabolites like glucose, water, amino acids take place.
v. The reabosorption of salt and water is regulated in the loop of henle
vi. In the distal convoluted tubule large waste molecules like creatinine are secreted into the tubule depending on blood concentration. If necessary

ions like hydrogen, potassium and hydrogen carbonate are also secreted into the tubule to keep osmotic concentration of the blood constant

vii. The filtrate moves into the collecting duct where further reabsorption of water takes place. And the remaining fluid becomes urine which trickles down into the ureter and urine is stored temporarily in the bladder.

Excretion of urine

As said earlier, the nephron is the unit of excretion. The renal artery carries waste products to the kidney. Ultrafiltration of waste products takes place in the glomerulus, inside the bowman's capsule. The filtrate moves own the kidney tubules. In the loop shaded region of the tubule more salts are added to the fluid, while water is removed from it.

The resulting fluid is urine. The urine is then moved to the bladder by peristalsis, where it is stored until it is get rid of.

NOTE: The descending limb of the loop of Henle is more permeable to water than the ascending limb.

Lesson Five

OSMOREGULATION

This is the process by which the osmotic pressure of the blood and tissue fluid is kept constant. Osmoregulation occur in the mammalian kidney during selective re-absorption and in the blood in the following ways:

(a) If the osmotic pressure of the blood increases more water is reabsorbed from the kidney tubule and less is passed into the bladder.

(b) If the blood osmotic pressure decreases only a small quantity of water is re-absorbed and more water is passed into the bladder.

Essentially the kidney carries out its function of osmoregulation in the following ways:

Water is constantly lost from the body through urine and other means. This is regained by drinking and eating moist food. If too much water is lost or if excess salts are consumed the osmotic pressure of the blood rises. The rise in osmotic pressure is detected by sensitive cells (osmoreceptors) in the hypothalamus of the brain. These causes the posterior lobe of the pituitary gland to release antidiuretic hormone (ADH) into the circulation. The effect is that more water is reabsorbed by the kidney in the distal convoluted tubule and the urine becomes more concentrated. The release of ADH therefore reduces the loss of water in urine and helps to maintain the osmotic pressure of the blood. But when the osmotic pressure of the blood reduces, this is detected also by the osmo-receptors in the hypothalamus of the brain which will make the posterior lobe of the pituitary gland to decrease or stop secretion of antiduretic hormone into the distal convoluted tubule of the nephron. Thereby less water will be reabsorbed by the kidney and the urine produced will be diluted and more.

REGULATION OF INTERNAL ENVIRONMENT

Homeostasis: This is the process by which the internal environment of the body of a living organ is regulated in order to maintain a steady and constant internal condition thereby preventing the damage of the cells of the body.

An organism regulates its internal environment and keeps it in a steady state by constantly adjusting the chemical and physical conditions of its body fluids. These conditions include: PH, pressure and concentration of dissolved substances in the fluids (such as Carbondioxide, Oxygen, Urea,) temperature etc.
The main organs and systems involved in homeostasis

i. Liver
ii. Kidney
iii. Skin
iv. hormones

But it should be noted that the brain has overall control over the homeostasis process in the body.

The kidney

The kidney apart from excretion, also carry out the important function of osmoregulation which has been discussed earlier.
The following factors affect the functioning of the kidney:

i. Water
ii. Salt content of the blood
iii. Environment temperature
iv. Diseases of the kidney

Diseases of the kidney

1. Diuresis: This caused by diabetes insipidus (the production of ADH stops or is greatly reduced) or excess alcohol. It is the passing out of excess watery urine when the tubules fails to reabsorb water back to the blood from the filtrate. This may lead to thirst and dehydration.
   Treatment: Treat diabetes and drink less alcohol
2. Kidney stones: These are precipitation of solid substances in the nephrons. They may block the tubules thus causing severe abdominal pain and difficulty in passing out urine. It is cured by the use of drugs.
3. Nephritis: This is caused by bacteria. The glomerulars inflamed, causing it to be more permeable, as a result a lot of useful materials in the body are lost through urine. It can be help using dialysis machine.
4. Oedema (dropsy) : This is the swelling of the part of the body caused by accumulation of intercellular fluid in the tissue. The legs (ankle) and the arm are very swollen and also a puffy face. Oedema may be caused by reduced plasma osmotic pressure has in certain kidney diseases condition.

Effect of kidney disease

The effects of the kidney diseases are due to impared kidney function. These are shown by the following signs

i. Presence of protein and blood cells in urine. This is caused mainly by increased porosity of membrane in the glomeruli and bowman's capsules.
ii. Impaired ability to produce sufficient urine. This takes place when the tubules are blocked or damaged.
iii. Acidosis: In this case, the PH of the blood drops and this is caused mainly by a decreased ability of the tubules to secrete hydrogen ions.

iv. High blood urea level: This occurs when the kidney function falls by about 50%
v. Oedema
vi. High blood pressure: Kidney with damaged or blocked glomeruli have a reduced blood flow through them. This stimulates the kidneys to produce renin, an enzyme that cause the activation and release of angiotensin, a hormone which constricts the arteriole in the whole body causing the blood pressure to rise.

How the kidney maintains Acid-Base balance of the blood

The pH of the human blood is neutral between pH 7.35 -7.45. Anything above or below this range is dangerous to the body. When the body fluid or blood becomes acidic, the cells of the distal convoluted tubules would reabsorb more hydroxyl ions from the urine.

More Hydrogen ions are then excreted making the urine acidic. If the body fluid or blood becomes basic i.e above pH 8, the hydroxyl ion content of the blood gets higher.

Then more hydrogen ion are produced absorbed by the cells of the distal convoluted tubules.

More hydroxyl are produced and excreted with the urine making the urine basic.

Note: Aldesterone secreted by the adrenal cortex stimulates or regulate the reabsorption or excretion of sodium ions.

Factors that affect functioning of the kidney

1. Environment temperature: In cold or low temperature, there is tendency to urinate more i.e more water is lost from the kidney by frequent urination thereby putting the kidney under much stress. But on hot days or when temperature is high less water is lost through urination.
2. Drugs: Diuretic drugs brings about excessive loss of water from the kidney, causing frequent urination
3. Fresh water habitat: Endosmosis occurs in fresh water leading to frequent in flow or water, resulting in production of diluted or hypotonic urine/copious.
4. Marine habitat: Exo-osmosis occurs in marine habitat leading to frequent loss of water to the environment. Resulting in the production of hypertonic and highly concentrated urine.
5. Arid or Desert habitat: More water is reabsorbed by the kidney in the henle's loop resulting in semi solid urine known as uric acid.
6. Disease: Disease like nephrit's, kidney stone etc brings about malfunctioning of the kidney e.g. passing out urine with protein and blood cells and also passing out urine with great difficulty.

KIDNEY STONE

Kidney stones are small solid crystal of concentrated uric acid of minerals found in the urea. They are found if there is an excessive loss of water or insufficient water in-taken. The solubility of minerals or calcium phosphate in the urea will be reduced and high level of uric acid or amino acid can lead to kidney stones. Bacteria may be trapped in the kidney tubule as the kidney stones get bigger.

Symptoms of kidney stones are:

Sharp pain at the flank of back, frequent uniration, nausea, sweating. kidney stones can be treated by medications, change in diet of food rich in calcium, surgery and drinking plenty of water.

Working of the Dialysis Machine

A dialysis machine is also known as an artificial kidney which is made up of a long coiled cellophane tube immersed in a water bath. The water in the bath contains all the useful ions and small molecules like glucose in the same concentration as in normal plasma and it is maintained at body temperature. To carry out dialysis on a patient, the blood from one artery in the arm is allowed to flow through the tube and the cellophane which is semi-permeable allows body waste to diffuse out of the blood into the water bath while retaining the plasma proteins and blood cells, only the excess amount of ions and glucose diffuse into the bath from the blood. The cleansed blood is returned to the body through a vein in the arm.

Drawing showing how a dialysis works

THE LIVER

The liver is the largest organ lying under the diaphragm and partly covering the stomach. It is reddish brown with two (2) lobes. Each of which is divided into smaller lobes. A gall bladder is embedded in the right lobe of the liver where bile is secreted by the liver is stored. The gall bladder is connected to the duodenum by bile ducts. It is located below the diaphragm at the upper part of the abdominal cavity.
The functions of liver has been discussed earlier

Structure of the liver

It is soft but firm to touch, dark red in colour with a smooth surface.

Diseases of the liver

i. Gall stones (calculus): small stones formed from insoluble deposits from bile in the gall bladder. Gall stones can be harmless but some pain and inflammation and a serious condition can develop if a gall stone blocks the bile duct – to correct this, reduce fats and oils intake, take plenty of water, avoid excess intake of calcium and removal of stones.

ii. Jaundice: condition where there is excess of bile pigment in the blood and where the pigment is deposited in the skin and whites of the eyes, the areas have yellow colour. It is caused by blockage of the bile ducts by gall stones or liver diseases.

iii. Cirrhosis: Condition where some cells of the liver die and are replaced by hard fibrous tissue. It may be caused by alcoholism, heart disease or viral diseases.

iv. Hepatitis: Inflammation of the liver. The infective hepatitis leads to Jaundice with the following symptoms abscess is caused by a liver parasite

v. Amoebic liver

- Yellow eye balls, palm and coloured faces
- Dark brown urine
- Fever
- Pains
- Nausea

Treatment: Avoid oily food, take vitamins, avoid protein diet and take glucose.

JAUNDICE

It may be due to three main cause, they are

1. Excessive breakdown of red blood cells
2. Obstruction of the bile duct
3. Diseases of the liver

HEPATITIS

Hepatitis is an inflammation of liver cells which can arise from bacteria or excessive consumption of alcohol. The symptoms include: fatigue, loss of appetite/anorexia, muscle pain and ache, nausea, fever, jaundice and dark colour urine.

Treatment of liver disease

1. Enough rest and sleep
2. Nutritious diet with low fat and protein
3. Avoid intake of alcoholic drinks
4. Removing the causes of liver disorder where possible e.g. in amoebic liver abcess the pus the obstruction is remove in bile duct obstruction.
5. Liver transplant.

Effects of diseases of the liver

The effects are due to the failure of liver cells to function properly. The common symptoms are:

i. Weakness and tiredness
ii. Jaundice
iii. Fever
iv. Oedema (accumulation of fluid in the abdomen)
v. Biliary colic

vi. High blood pressure

Diagram of the position of the liver relative to the alimentary canal

Lesson SIX

THE SKIN

The mammalian skin is the largest organ. It consists of two main layers: the epidermis and dermis.

The epidermis consists of three (3) layers:

- Malpighian layer (inner) (germinative layer
- Granular layer (middle)
- Cornified layer (outer) (Horny layer)

The malpighian layer consists of cells which contain melanin (pigment that gives the skin its colour). The granular layer consists of living cells pushed up from the malpighian layer. The cell continue to move to the surface of the skin and in the process they become flattened, accumulate keratin (a fibrous protein) and eventually die. The cornified layer contains keratin which makes it flexible and water proof

The dermis is a layer of connective tissues contains

- Blood capillaries: They bring food and oxygen to the dermal and epidermal cells and remove their wastes. The capillary loop close to the body surface help to regulate the body's temperature.
- Hair follicles: A hair erector muscle is attached to each follicle when it contracts it pulls the hair to a more erect position. When we feel cold, the hair erector muscles contract and we get "goose pimples". The erector muscle also contract in furry animals causing their fur to stand up and trap more air within it.

- Sebaceous glands: They secrete sebum (oily substance) into the hair follicle which keep the hair and epidermis waterproof and supple and also keep microorganisms and dust out.
- Sweat glands: found deep in the dermis and it continues as sweat ducts that opens at the surface as sweat pore. The cells of the coiled tubes absorb water containing small quantities of mineral salts, urea which is known as sweat from the capillaries surrounding them and secrete them into the tubes. When sweat gets to the skin surface and evaporates, it cools the body.
- Sensory nerves endings: Since the skin is also a sense organ, it contains sensory cells which receives stimuli from the external surroundings and send them to parts of the body for proper interpretation and action.
- Fatty layer: This is just below the dermis and it contains a large number of fat cells which is called the subcutaneous fatty (adipose). It stores food for a very long time, and also prevents heat loss from the body.

Effect of lack of sense receptor in the skin

Human will not be able to feel or sense external stimuli in their environment like temperature which can lead to death

Functions of the skin

1. For protection due to its waterproof nature
2. Sensitivity: It is sensitive to touch, pressure, heat, cold and pain
3. Excretion: The skin excretes excess water, mineral salts and some nitrogenous wastes through sweat glands as sweat.
4. Regulation of temperature of body: Animals are able to regulate their body temperature in their various environment, based on this vertebrates are grouped into two (2) categories:
   (a) Poikilothermic animals: These are animals whose body temperature changes according to the environmental temperature (they never have a constant body temperature) e.g. fish, amphibians, reptiles.
   (b) Homoiothermic animals: These are animals whose body temperature remains constant inspite of changes in environment e.g. birds, mammals.

Note: Normal human temperature is between 35.8^{o}C- 37.7^{o}C. Body temperature below 27^{o}C and above 42 ^{o}C cause death in humans.

How the body regulates its temperatures

When there is an increase in body temperature, the body can lose heat through the following ways:

(a) Vasodilation: The capillaries near the surface of the skin dilate while those deep in the skin layers constrict. This will give rise to flow of a large volume of blood to flow near the surface of the skin so that heat is lost to the surrounding through conduction, convection and radiation, reducing the body temperature
(b) Sweating: Human being sweat when heat is too much and as the sweat evaporates, heat from the body is used is used up, thus cooling the body.
(c) Behavior changes: mammals keep cool by staying in the shade. Humans wear light clothing.

(d) Decreasing metabolic rate: The body slows down its rate metabolic activities to reduce the heat released by metabolic reaction, thereby reducing heat production in the body.

When there is decrease in environmental temperature, the body gains heat through the following processes

(a) Vasoconstriction: The capillaries near the skin surface constrict while those situated deeper dilates. This will make a smaller volume of blood to flow near the surface of the skin so that heat loss will reduce. This conserves body heat.

(b) Sweating: When the environment is cold, the sweat glands become inactive and produce little sweat thereby heat loss through evaporation of sweat will be reduced.

(c) Behavioural changes: Human wear woolen clothing to warm and many mammals keep warm of huddling into a ball and also staying in nest.

(d) Increasing metabolic rate: The body increases its metabolic rate, especially the liver to produce more heat. Shivering also increases the body's metabolic rate.

The heat loss centre and heat gain centre are the two parts of the thermoregulatory centre located in the brain

5. Production of vitamin D
6. Production of milk

<u>Role of hair shaft in temperature regulation</u>

During hot weather when temperature increases the erector muscle of the hair relaxes. The hair shaft bends or is lowered then les air is trapped between the hair and the skin and heat is lost from the body through conduction, convection and radiation bringing the body temperature back to normal or reducing the body temperature. But when it is cold the erector muscles contract making the hair shaft to stand erect. A layer of air is trapped between the hair and skin. Heat is retained thereby increasing the body temperature and bringing it back to normal.

<u>Care of the skin</u>

1. Regular cleaning of the skin with milled soap and clean water at least twice daily
2. Exposure to fresh air, we should expose our skin to fresh air and sunlight always
3. Eating of balanced diet.
4. Regular exercise
5. Proper treatment of skin diseases and infection
6. Treating of wounds and cuts if any is found on the skin
7. Avoiding of the use of injurious chemicals or bleaching creams

Diagram of the longitudinal or vertical section of the mammalian skin

Lesson Seven

Hormones

Hormones are chemical substances produced in minute or small quantities by the endocrine glands in one part of an organism and transported to the site of action by blood stream where they exact specific effect or response to control body metabolism.

Hormones are produced by ductless glands (endocrine glands) are so called because they have no duct but their secretions diffuse directly into the blood which carries them to all parts of the body including the organs and tissues they affect. Target organs have cells with special receptor molecules on thier surface into which appropriate hormones can fix and bring about specific effect.

The main endocrine glands are:

i. Pituitary gland
ii. Pancreas
iii. Parathyroid gland
iv. Thyroid gland
v. Ovaries (female gonads)
vi. Adrenal glands
vii. Testes (male gonads)

General functions of hormones

i. It controls growth
ii. It helps in sexual maturity
iii. It helps to regulate the composition of the internal environment (homeostasis)

iv. Hormonal actions are responsible for the changes in the cells which enable absorption of food and the preparation of waste products for excretion.
v. It coordinates organs of the body
vi. Hormones partly regulate the circulation of blood.

Characteristics of hormones

i. The hormones are carried to all parts of the body by the blood stream
ii. Hormones bring about a specific effect on certain part of the body
iii. Very minute quantity of hormones are needed to exert this effect.
iv. Although the endocrine gland may be separated from one another, they influence one another and as a result of this interactions, they are integrated into a highly coordinated system called the endocrine system.

Diagram of the major endocrine glands of human body

S/N	Endocrine glands	Location	Hormone secreted	Function
i	Pituitary gland (sometimes called master gland because it regulates the activities of other endocrine organs by its secretion	Base of the fore brain	(i)prolactin (ii)Oxytocin (iii)Antidiuretic hormone (ADH)	Stimulates and controls milk production by the mammary gland. Controls the flow of milk in the mammary glands and contraction of the uterine walls It stimulates the kidney tubules to reabsorb water from the glomerular filtrate
ii	Thyroid gland	Anterior region of the neck	Thyroxine (it contains iodine)	i)Speed up or regulate the rate of body metabolism especially aerobic respiration ii)stimulates mental and physical growth and development in young animals iii)controls metamorphosis in tadpoles
iii	Parathyroid gland	Anterior part of the neck near the thyroid gland	Parathyroid hormone	Maintain normal level of calcium ions and phosphate ions in the body
iv	Pancreas (islet of langerhans)	Within the loop of duodenum	Insulin Glucagon	-Regulates the amount of sugar in the blood -It promotes the uptake of glucogen and increases the rate of conversion of excess glucose to glycogen. -Increases blood sugar by stimulating the reconversion of glycogen to glucose
v	Adrenal gland	At the top of the kidney	Adrenalin (emergency hormone)	-Increases heartbeat and respiration -Increases sugar content of blood -aids dilation of the pupils -increases the muscular tone -Responsible for shivering during cold -Prepares the body for emergency -It is associated with fear and anxiety.
vi	Male testes (male gonads)	Scrotum	Testosterone	-stimulate/formation of secondary sexual character

				in male -Stimulates production of spermatozoa by the testes
vii	Female ovaries (female gonads)	Within the ovaries	i)Oestrogen ii)Progesterone	-Stimulate the development of female secondary characters. -Prepares the uterus for attachment of the embryo -Maintains the foetus during the development in the uterus

S/N	Hormone	Effects of oversecretion	Effects of undersecretion
i	Pituitary growth hormone (somatotropin)	Leads to gigantism in children while in adult it leads to acromegaly – this is when there is an increase in the size of the head, hand, body, legs etc	It leads to dwarfism in children
ii	Adrenalin	-increase excitement and over anxiety -increases blood pressure and heart beat -increases dilation of the pupil -leads to heavy breathing -results in profuse sweating	-slow reaction to emergencies -low heart beats -low blood pressure
iii	Insulin	-Results in hypoglycermia -leads to incessant hunger -Leads to fall in blood sugar level	-causes diabetes(mellitus and Inspidus) -leads to high blood pressure -leads to less appetite and great thirst -leads to general weakness
iv	Thyroxine	-it results increase metabolic rate -leads to restlessness -leads to loss of weight -brings about bulging of eyeballs	-results in low metabolic rate/cretinism in infact -leads to sluggishness -may result in goitre -in infants results in a condition called cretinism – (i.e defective development usually dwarf in size has puffy skin and sex organ is not developed and is also mentally retarded) -After maturity the defect is myxoedema (obese, sluggish, reduced heart rate, lower body temperature)

v	Testosterone	-leads to excessive development of sexual organs and secondary sexual characters. -leads to abnormal urge for sex in males	-leads to underdevelopment of sexual organs -leads to low urge for sex in males
vi	Oestrogen	-result in abnormal urge for sex in females -leads to early maturity of secondary sexual characters in females	-There is delayed secondary sexual maturity. -poor development of reproductive system
vii	Parathyroid hormone	-brings about increased loss of phosphate -causes softening of bones	-leads to uncontrollable muscular spasmodic spasms and possibly to death.

Pituitary gland

Hormones	Function
Adrenocorticotropic hormone (ACTH)	Stimulate the adrenal cortex to produce its hormones, the corticosteroids
Thyroid-stimulating hormone (TSH)	Stimulates the thyroid gland to produce their hormones thyroxine
Follicle-stimulating hormone (FSH)	Causes follicles in the ovary to ripen and produce mature eggs. Initiates sperm formation testis
Lutenizing hormones	Causes ovulation (release of mature eggs in the fallopian tube)
Growth hormone (GH)	Stimulates growth of long bones Promotes protein synthesis and increases metabolic rate in cells
Prolactin	Induces milk production in pregnant women
Anti diuretic hormones (ADH)	Increases reabsorption of water by kidney tubules. Raises blood pressure by constricting arterioles
Oxytocin	Induces birth by contraction of uterine muscles Induces milk secretion from nipples.

PSH and LH are commonly known as GONADOTROPIN

Role played by adrenaline in an emergency situation

1. Adrenaline is secreted during an emergency situation often caused by sudden rage or fear.
2. It stimulates the sympathetic nervous system and many different organs for action.

3. The breathing centre in the brain induces faster breathing and deeper breathing
4. Thereby increasing the absorption of oxygen into blood and removal of carbondioxide from it.
5. The heart beats faster and blood pressure increases
6. Thereby increasing the rate at which oxygen and glucose are distributed to body cells.
7. The liver increases rate of conversion of glycogen to glucose available for energy production.
8. The spleen releases more red blood cells from it reserves to enhance oxygen uptake.
9. Arterioles of lungs, voluntary muscles dilates to increase blood flow and hence glucose and oxygen supplies in organs will be directly involved in emergency actions.
10. Smooth muscles of alimentary canal relax and voluntary muscles of bodies become tensed preparing them for immediate action.
11. Sensory perception and mental awareness increase
12. Then the pupil is dilated increasing range of vision.

Types of goitre

Hyperplastic goitre is caused when the thyroid gland comes under prolonged stimulation by the thyroid stimulating hormone. Due to a low thyroxine level in the blood, it becomes hyperactive and enlarges to form a hyperplastic goitre.

Oversecretion of throxine also results in an enlarged thyroid gland known as exophthalmic goitre. A person with this condition is hyperactive, irritable, nervous and thin with bulging eyes.

Adrenal hormone: The adrenal gland is divided into two parts. The outer adrenal cortex and thinner adrenal medulla.

ADRENAL CORTEX HORMONE

The adrenal cortex produces an hormone known as corticoids or corticosteroids. The corticoids can be grouped into two; they are

i. Glucocorticoids
ii. Mineralocorticoids

Adrenocorticotropic hormone (ACTH) stimulates their production. The adrenal medulla are adrenaline and Norfadrenaline.

Body Responses Produced By Adrenaline and noradrenaline

	Effect	Purpose
1.	Breathing centre in brain induces faster and deeper breathing, dilates bronchioles	More air is breathed in and out, increasing absorption of oxygen into blood and removal of carbodioxide from it.
2.	Heart beats faster, blood pressure increases	Increases rate at which oxygen and glucose are distributed to body cells.
3.	Liver increases rate of conversion of glycogen to glucose	Increases blood sugar level so that more glucose is available for energy production, especially in muscle
4.	Spleen releases more red blood	Enhances oxygen uptake from lungs and

	cells from its reserves	transport to body cells.
5.	Arterioles of skin and alimentary canal constrict.	Decreases blood flows in skin and alimentary canal allowing more blood to flow through liver and voluntary muscles, organs directly involved in emergency action.
6.	Arterioles of lungs, voluntary muscles and liver dilate.	Increases blood flow and hence glucose and oxygen supplies in organs directly involved in emergency action.
7.	Smooth muscles of alimentary canal relax	Slows down peristalsis and digestion making more energy available for action (voluntary muscle contraction)
8.	Voluntary muscle of body become tensed	Preparing them for immediate and vigorous action
9.	Sensory perception and mental awareness increases	Enable rapid detection and response to external stimuli.
10.	Pupils of eyes dilate	Increases range of vision, important in detecting visual danger signals in surroundings

NOTE: The constructing of the arterioles of skin and alimentary canal is mainly due to noradrenaline

Lesson Eight

Structure and function of Gonads

Gonads are the male and female reproductive organs in animals.

Human Male Gonads

Sperm cell is produced by the testes.
The human male gonads consist of two testes enclosed in a scrotum (a bag of skin) which is attachable to the pubic region. Each testes contain many seminiferous tubules in which sperms are formed. The two testes lie outside the abdominal cavity in man, in the scrotum, consequently, the testes remain at a temperature below that of the rest of the body which is favourable for sperm production. The testes is attached to the scrotal wall by a tissue called Gubernaculum.
Epididymis leads from the testis into the vas deferens or sperm duct, which carries sperm to the seminal vesicles where sperms are stored until ejaculation. The prostate gland secretes a liquid which sperms are suspended, the sperms pass to the outside through the urethra.

Functions of the Male Gonad (Testes)

i. Testes produce sperms cell / spermatozoa
ii. Secretion of the hormone testosterone

Effects of testosterone

i. It produces male secondary sexual characteristics e.g. pubic hair, broken voice, hair on the chest etc.
ii. It makes the testes develop and descend to a position below the abdomen

Human Female Gonads (ovary)

This consists of two ovaries located at the dorsal surface of the abdominal cavity, one on each side of the vertebral column: Each one produces one egg or ovum

(plural ova) every month (working alternatively). The eggs are released by the ovary passed into the oviduct or fallopian tube and then to the uterus. Fertilization occurs in the oviduct

In the female human being, the urinary passage and genital passage do not join to form a common duct but open to the exterior by separate openings.

Functions of the Human Female Gonad

i. Ovaries produces egg
ii. Secretion of sex hormones known as Oestrogen and Progesterone

Effects of Oestrogen

i. Stimulates the lining of the uterus
ii. Produce and maintain female secondary sexual characteristics e.g. pubic hair, development of breast etc.

Effects of progesterone

It prepares the uterus for implantation of an embryo. If fertilization does not occur, the thick lining of the uterus breaks down, producing the monthly menstruation.

Definition of terms

1. Testes:- produce sperm cell and sex hormones for secondary sexual characteristics in male
2. Seminiferous tubule:- Where sperm is formed inside the testis
3. Epididymis:- stores sperm temporarily
4. Vas deferens or sperm duct:-it carry sperm from epididymis to seminal vesicles
5. Seminal vesicle:- stores sperm until ejaculation and secretes seminal fluid to the sperm.
6. Prostate gland:- secretes part of seminal fluid which activates the sperm. It contains fructose to activate the sperm cell.
7. Cowper's gland:- Secretion raises pH of fluid in female reproductive system (seminal fluid)
8. Scrotum:- it contains and protects testes
9. Urethra:- Canal in penis through which semen fluid and urine passes out.
10. Penis:-Erectile and intromitent organ, introduces sperms into female reproductive system.
11. Seminal fluid:- It is secreted by three organs: Seminal vesicles, prostate and cowper's gland. It contains fructose which provides energy for the sperm. It neutralizes the acidity of urine and lubricates sperm passage.
12. Ovary:- Produces ovum and sex hormones
13. Oviduct:- where fertilization occurs (upper part)
14. Uterus:- for implantation of embryo and support the foetus throughout the period of development.
15. Vagina:- where penis enter and sperm is deposited and baby also passes out of the vagina during birth.
16. Clitoris:- sensitive structure near the entrance of the vagina. It contains erectile tissue, found above the vulva.
17. Vulva:- Mouth or opening of the vagina

Advantages of sexual reproduction

i. It is for continuity of species
ii. It is for production of hybrids for some desirable traits
iii. It enhances survival in new environment

iv. It causes variability of individuals / causes variation
v. It provides means for the maintenance of chromosome number from generation to generation.

Description of the female Human Reproductive System

It possesses two oval (ovaries), attached to the body wall in the lower region of the abdominal cavity. Ovaries contains eggs (ova). A fallopian funnel lies close to each ovary. The fallopian funnel leads into the fallopian tube or oviduct. The fallopian tube continues downwards and joins the uterus or womb which has a thick elastic wall. The muscular neck of the uterus known as the cervix projects into the vagina. The mouth or opening of the vagina is the vulva surrounded by two lips. Above the vulva is the clitoris containing erectile tissues.

Drawing of the male reproductive system

Drawing of the female reproductive system

Functions of the female reproductive system

i. It produces eggs / ova for ovulation
ii. It prepares the uterus to receive the fertilized egg (zygote)
iii. It provides food and protection for the foetus throughout the gestation period.
iv. It expel unfertilized egg and other unused materials during menstruation
v. It provides female hormone to maintain menstrual cycle
vi. It expels the matured foetus from the uterus when the foetus is ready to be born.

Functions of the male reproductive system

i. Formation of sperms to fertilized the eggs of the female
ii. Production of male hormones
iii. Introduces sperm cells by the help of the penis into the vagina of the female to fertilize the egg.

Note: Semen is made up of secretions from the cowper's gland, seminal vesicle, prostate gland and sperm cells. (Semen is made up of seminal fluid and sperm cell)

Male and female gametes

The gametes are produced in the gonads by a process called Gametogenesis. The two critical events in sexual reproduction are meiosis and fertilization. Meiosis halves the number of chromosomes sets in the nucleus to produce haploid (n) cells which will form or give rise to haploid structures that eventually produce gametes. Fertilization will combine the chromosomes in two haploid gametes (structures) to produce a diploid (2n) zygote. Organism development from a zygote are made up of diploid cells.

Mammals

Reproduction in mammals is viviparous

Similarities between male and female reproductive systems

i. The gonads found in both acts as ductless glands (endocrine glands)
ii. Both have tubes through which gametes pass
iii. Both produce gametes
iv. Both contain gonads (testes and ovaries)
v. Both have external openings

Differences between male and female reproductive systems

	Male Reproductive system	female Reproductive system
i.	Cervix is absent	Cervix is present
ii.	Prostate gland present	Prostate gland absent
iii.	Gonads are located outside the body	Gonads are located inside the body
iv.	Presence of testes	absence of testes
v.	No oviduct	Oviduct present
vi.	No uterus	Uterus present
vii.	Cowper's gland present	Cowper's gland absent
viii.	Penis present	Penis absent
ix.	Vagina absent	Vagina present
x.	Sperms pass out through urethra	Ova passes out through vagina if not fertilized.

Structure of mammalian gametes

Gametogenesis is the formation of gametes and it takes place in the gonads.

Male gametes

The male sex cells are called sperms and they are produced in the testes by a process called spermatogenesis. The sperm or spermatozoa (i.e. a matured one) has a head, middle piece and a tail.

Drawing of the structure of the sperm cell

The human sperm is usually smaller than the ovum it is about 0.5mm long.

(i) Acrosome: It contains lytic enzymes or agents to dissolve the egg membrane to enhance penetration of the sperm cell during fertilization.
(ii) Middle pieces: It contains many mitochondria which generates the energy used by the sperm cell to swim towards the egg.
(iii) Tail or Flagellum: it helps to move the sperm cell.
(iv) Nucleus: It contains genetic materials which fuses with the nucleus of the egg during fertilization.

Female gametes

The female sex cell (gametes) called ova (eggs) are produced in the ovaries by a process called oogenesis. It is spherical and non-motile with a large nucleus. Ova can only be produced during breeding season (ovulation) unlike the male sex cells which can be produced at any time. Ovum consists of the cytoplasm, a nucleus, granules and yolk droplet. The yolk is a stored food for developing embryo. The ovum cytoplasm is surrounded by two membrane by jelly coat. The nucleus contains chromosome which carry genes and the genes are responsible for transmission of characters from parents to offspring.

Drawing of the structure of an egg or ovum

Differences between the sperm and ovum (egg)

	Sperm cell	Ovum / egg
i.	It is motile	It is non-motile
ii.	Tail is present	Tail is absent / No tail
iii.	It has head	Head are absent
iv.	There is absence of vitelline membrane	Vitelline membrane is present
v.	It is not visible to the naked eye	It is visible
vi.	Food reserve / yolk is absent	Yolk is present/food reserve is present
vii.	It has a small cytoplasm	It has a large cytoplasm

Production of eggs/ova

The production of mature ova is cyclical in a female. The ovaries contain potential egg cells (primary Oocytes) and just about 400 out of 200,000 oocytes develops into mature ova during a females active reproductive life.

The process of production of eggs involves the following major events in the ovary and uterus.

i. Maturation of an ovum in one of the ovaries
ii. Thickening of the uterine endometrium
iii. Maintenance of the uterine endometrum for receiving fertilized ovum
iv. Breakdown of the extra uterine endometrum tissue if fertilization of the ovum and implantation doesn't occur.

Each egg is surrounded by nutritive cells called Graffian follicle when the eggs reaches the mature egg. The release of egg is known as ovulation.

The Graffian follicle stays behind in the ovary and develops into a yellow body called corpus luteum and this produces a hormone called progesterone. About two weeks after ovulation, the corpus luteum withers away, the progesterone ceases and lining of the uterus breakdown if fertilization does not occur. The released ovum is surrounded by a protein coat known as Zora pellucida and layer of nutritive cells.

Organs in mammals that produce sex hormones

i. Ovary – oestrogen, progesterone
ii. Testes – Testosterone, Androgens
iii. Placenta – Progesterone
iv. Adrenal glands – Androgens
v. Pituitary gland – follicle stimulating hormone (FSH), Luteinising hormone (LH), prolactin, oxytocin.

Menstruation cycle (oestrous cycle

Menstruation cycle is the series of changes that occur in the reproductive organs of a mature female to release an egg on the average of every 28 days under the influence of hormones. The changes are accompanied by discharge of blood, mucus, unfertilized egg and uterine materials resulting from the sloughing of the extra uterine endometrical tissue formed during the preceding menstrual cycle. The bleeding lasts for 4-5 days.

Four hormones controls the Menstruation cycle:

i. Follicle – stimulating hormone
ii. Oestrogen
iii. Luteinising hormone
iv. progesterone

Fertilization

This is the fusion of the nucleus of the sperm and the nucleus of the ovum to form a zygote. The fertilized egg is known as a zygote. Fertilization occurs is the oviduct. The 2 haploid nuclei fuses together to form one diploid zygote. Immediately after zygote formation, fertilization membrane is formed around the zygote to prevent sperms from entering the zygote.

Implantation of Embryo

The zygote divides mitotically into two halves and then continues to divide to form a solid ball of cells known as cleavage of zygote.

A knob of cells forms at one side within this ball. This gives rise to the embryo. The ball of cells moves along the oviduct to the uterus and the movement is aided by the peristalstic contractions of the fallopian muscles and last for five to seven days before arriving in the uterus.

On reaching the uterus, the embryo gets itself firmly implanted in the uterus wall. The embryo at first feeds on the yolk of the ovum and the food substances in the fluid of the uterus. As it grows, it develops placenta and embryonic membranes.

The embryonic membranes are amnion and chorion. The amnion forms a fluid filled sac that encloses the embryo and protects it. The chorion form the embryonic part of the placenta.

Placenta is a disc of vascular tissue formed partly by embryonic tissue and partly by uterine lining. The embryo is attached to the placenta by an umbilical cord which contains an artery and a vein.

The placenta occurs at the point of attachment of the embryo to the uterine wall. The amnion and chorion meets at this point.

The main organs associated directly with the placenta are the uterus and umbilical cord.

Drawing of menstral cycle

Hormonal Control of menstral cycle

The functions of the four hormones that control the menstral cycle are as follows:

1. Follicle stimulating hormone starts the cycle by stimulating follicle development
2. Oestrogen: This is secreted by the developing follicle and it brings about building up of the uterine endometrium. When there is a critical oestrogen level in the blood, it stimulates the release of luteinising hormone.
3. It triggers ovulation and corpus luteum development
4. Progesterone and oestrogen: It is secreted by the corpus luteum and it maintains the enriched endometrium. Progesterone also inhibit FSH so that new follicles do not develop.
5. Progesterone and oestrogen production stops when the corpus luteum shrivels and the cycle ends here

In the absence of progesterone, the enriched endometrium breaks down and the FSH production begins progesterone will inhibit FSH while oestrogen will stimulate LH. FSH stimulates oestrogen while LH stimulates progesterone.

Ovulation

28 days menstral cycle- 14 would be the ovulation period- at least 4-6 days survival of egg

Safe period

Periods which a woman cannot get pregnant within her menstral cycle is known as safe period.

Drawing of the relationship between the blood supplies of the foetus, placenta and uterus

Description of the mammalian placenta

The mammalian placenta is a mass of vascularized tissue, formed partly by embryonic tissue and tissue of the uterine lining (endometrium). It is linked to the foetus by the umbilical cord which carries the umbilical artery and vein. It has villi which projects into the maternal blood space in the uterine lining. This brings the foetal and maternal blood supply into very close contact without mixed. A thin barrier between the maternal and foetal blood supplies known as tropoblast allows a selective exchange of material between them.

Functions of placenta

i. Establishes connection between the embryo and the mother.
ii. Carries oxygen / water/ digested food from mother's blood to foetus (N.B by diffusion)
iii. Removes or filters out waste / urea / carbondioxide / salt from foetus blood to mother's blood for elimination.
iv. Produces progesterone for maintenance of uterine wall.
v. Carries antibodies from mother's blood to foetus.
vi. It prevents the mixing of foetal and mother's blood
vii. It converts glucose to fructose

Functions of umbilical cord

i. It attaches the foetus to the placenta
ii. The vein in the umbilical cord transports digested food and oxygenated blood from placenta to foetus.

iii. The artery transport waste metabolic products / excretory products and deoxygenated blood from foetus to the placenta.
iv. It supports foetus in the amnion cavity.

Functions of amnion

i. The amniotic fluid protects the embryo from shock and mechanical injury.
ii. The amniotic fluid provides a suitable temperature for the embryo and allows it to move freely.
iii. The amniotic fluid is slippery and therefore helps for easy passage of the foetus during child birth.

Tropoblast is a thin barrier between the material and foetal blood which allows selective exchange of materials between them.

Functions of chorion

i. It protects the embryo outside
ii. It helps in formation of the placenta

All the major organs are formed in the embryo by the end of 10 to 12 weeks and it is known as a foetus. Gestation period in human in 38 weeks.

Parturition (Labour) / Child birth

Parturition is the expulsion of the foetus, placenta and foetal membranes from the uterus. Three stages are involved in childbirth.

i. Dilation period: There will be opening and expansion of the cervix. The amnion and chorion burst releasing the amniotic fluid to the vagina
ii. Expulsion stage: The position of the foetus should be head down the cervix and vagina fully enlarged. Contraction of the uterus muscles becomes stronger and frequent which helps to push the baby out.
iii. Expulsion of placenta and membrane: These are known as after birth

Drawing of a developing foetus in human

Lesson Nine

TWINS

There are two types of twins. There are fraternal twins and identical twins.

Identical twins: They are produced when one egg is released from the ovary into the oviduct and fertilized to form a zygote, the zygote divides into two equal halves and then develops into two identical individuals. Identical twins share the same placenta and chorion.

Features of identical twins

(i) They are of the same sex
(ii) They have similar genotype
(iii) They develop from the same zygote
(iv) They have similar physical features

Fraternal twins: These are unidentical twins. They develop and form two eggs and each is fertilized by a separate / two sperm cells. Two babies are produced which may be of the same sex or different sex and the genotype is different. Each developing foetus have it own placenta and chorion

Siamese twins: These are produced when a fertilized egg splits incompletely.

Triplets: These are formed by a set of identical twin and one ordinary baby.

Quadruplet: These are formed when one fertilized egg splits into four parts before developing or two fertilized eggs with each producing identical twins.

Adaptation of the embryo to life

(1) The embryo is adapted to life by the placenta. A structure that allow the embryo to remove waste product through the mother at the same time obtain oxygen, water, digested food and antibodies.
(2) Presence of amniotic fluid serves as a shock absorber and protect the embryo from injury and damage.
(3) High vascularized umbilical cord that connect mother to foetus to promote exchange of materials

Process of formation of embryo

(1) The process by which the embryo is formed is called sexual reproduction
(2) During mating the male human introduced the erect penis into vagina of a female human.
(3) Thereby releasing sperm into the vagina
(4) Sperm swim into the uterus through the cervix.
(5) Then into the oviduct to meet a matured egg.
(6) Which has been release from the ovary during ovulation.
(7) The sperm fertilizes the egg to form a zygote
(8) Which then migrate into the womb or uterus and become implanted into the inner lining of the uterus.
(9) This develop into the foetus.