BASIC SCIENCE JS 2

FIRST TERM NOTES (2024/2025 SESSION

SCHEME OF WORK

Week 1: Skeletal System

Week 2: Muscles and Joints

Week 3: Excretory System

Week 4: Excretory System

Week 5: Respiratory System

Weak 6: Circulatory System

Week 7: Circulatory System

Week 8: Digestive System

Week 9: Digestive System

Week 10: Revision

SKELETAL SYSTEM

The skeletal system consists of all organs in the body that makes up the skeleton. Skeleton can be defined as the framework of an animal's body that provides support, rigidity, shape, aids in movement and protects delicate organs in the body.

The skeleton in animals is made up of the following materials:

a. Bones

b. Cartilage

c. Chitin or Cuticle

BONES

Bones are hard tissues that make up the skeleton of vertebrates. They consist of living cells called Osteocytes, Protein fibre called collagen and chemical compounds (or minerals) which are Calcium (II) tera oxo phosphate (V) and calcium (II) tri oxo carbonate (IV). Bones can grow; and when they break, the doctor may put plaster of Paris (P.O.P) around the broken bone to hold it together until it heals.

CARTILAGE

Cartilage is a tough flexible tissue that provides support to the skeletal bones in vertebrates and allows bones at joints to move without rubbing against each other. They consist of living cells called Chondrocytes. Cartilage forms the entire skeletal system of animals like sharks and rays.

There are three (3) types of cartilage:

- Hyaline cartilage: found in trachea, bronchi, surfaces of movable joints, and the protruding part of the nose.
- Fibro cartilage: this is tougher than hyaline cartilage. It is found in the discs between the small bones of the vertebral column.
- Elastic cartilage: this is found in the external ear (pinnae) and epiglottis.

CHITIN OR CUTICLE

This is a tough, light, flexible, semi-transparent carbohydrate material that forms the skeleton of Arthropods, like Insects, Prawn, Crab, Millipede and Spiders; where it serves as a protective outer covering.

TYPES OF SKELETON

There are three major types of skeleton. These are:

a. Endoskeleton
b. Exoskeleton
c. Hydrostatic Skeleton

a. Endoskeleton: this is a skeleton found inside the body of vertebrates. It is made up of bones and cartilage and grows steadily as the animal grows. Examples of animals with endoskeleton are Fishes, Man, Lizard, Goat, Rat, Cow, Snake, etc.

b. Exoskeleton: This is a skeleton found outside the body of invertebrates. It is made up of chitin and is found in invertebrates like Fly, Cockroach, Crab, Millipede, Spider, Grasshoppers, Snail etc. Exoskeletons do not grow, therefore, time to time; invertebrates shed or cast off their

exoskeletons through a process called Molting or Ecdysis. This enables them to increase in size before a new exoskeleton is formed. Invertebrates molt unit they reach their adult size.

c. **Hydrostatic Skeleton:** this is a type of skeleton found inside the bodies of soft-bodied animals like Earthworms, Roundworms, Hydra, Amoeba, Tubeworms etc. This skeleton is neither made of bones or cartilage; instead it is made up of water or fluid. The pressure provided by liquid or fluid in the animal's body to provides shape, support and aids movement.

THE HUMAN SKELETON

The human skeleton is sub-divided into two main parts, namely:

a. Axial Skeleton
b. Appendicular Skeleton

The Axial skeleton consists of the following:

a. Skull
b. Breast bone or Sternum
c. Vertebral column or Backbone or Spine
d. Ribs

The Appendicular skeleton consist of

i. The Limbs
ii. The Limb girdles.

The limbs consist of fore limb and hind limb. The fore limb consists of the following bones, Humerus, ulna and radius, carpals, metacarpals and phalanges. The hind limbs consists of bones like, Femur, tibia and fibula, patella, tarsals, metatarsals and phalanges. The phalanges are the fingers and toes. The arrangement of the fore limbs and hindlimbs is called pentadactyl arrangement. (i.e 5 digit pattern)

The limbs girdles are:

a. The pectoral girdle: which is also called shoulder girdle. It consists of the scapula or shoulder blade found at the back and the clavicle or collar bone found at the front of the neck.

b. The Pelvic girdle or Hip girdle: consists of the hip bones (which are Ilium, Ischium, and Pubis) and the Sacrum. The pelvic girdle is designed to carry the weight of the upper body and pass it out to the legs.

Parts of the axial skeleton

1. **The skull**

The mammalian skull is made up of several flat bones which is joined together by means of several non-movable joints called suture joint.

The skull has three major parts; these are:

a. The cranium or brain box which houses the brain.

b. The orbit: a round cavity which supports and houses the eye.

c. The Jaws: which is consists of the upper jaw called maxilla and the lower jaw, known as mandible. The jaws bear the teeth.

The functions of the skull include:

a. It protects and covers the brain.

b. It carries and protects the sense organs.

c. It gives shape to the head.

d. It bears the teeth, which is used for grinding of food.

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S/No.	Type of vertebrae	Location in the body	Number in Man	Number In Rabbit	Number in Rat
1	Cervical bone	Neck region	7	7	7
2	Thoracic bone	Chest	12	12	13

		region			
3	Lumbar bone	Waist region	5	7	6
4	Sacral bone	Hip region	5	3-4	4
5	Caudal bone	Tail region	4	16	27-30
	Total		33	45-46	57-60

2. **The spine or vertebral column or backbone**

The backbone is the central supporting structure of the human skeleton. Without the backbone, we would not be able to stand erect. Each bone of the vertebral column is called a Vertebra (plural: Vertebrae). There are thirty-three (33) vertebrae in the human vertebral column. The back bone starts from the skull down to the neck, the trunk, the waist and ends at the hips.

There are five (5) types of vertebrae in mammals. These are:

In man, the sacral vertebrae fuse together to form a single bone called Sacrum. While the caudal vertebrae fused to form a bone called Coccyx.

Features of a typical vertebra

The following features are seen in a vertebra:

1. Neural canal: for passage of spinal cord
2. Neural arch: this is a bony curve surrounding the neural canal. It provides surface for muscular attachment.
3. Centrum: is a thick bony section. It is for strengthening of the vertebra.
4. Neural spine: for attachment of muscles.
5. Transverse process: for attachment of muscles and ligaments.
6. Zygaphophysis: These are facets for articulation

3. **The ribs and sternum**

There are twelve (12) pairs of ribs in the human body. They are attached to the sternum the front and the thoracic vertebrae at the back; however, the last two pairs of ribs in humans are not attached to the sternum;

these ribs are called floating ribs. The ribs, sternum, thoracic vertebrae and intercostal muscles form the rib cage.

The functions of the ribs cage include:

i. The rib cage aids in respiration

ii. The rib cage protects delicate organs like the heart and lungs.

FUNCTIONS OF THE SKELETON

The major functions of the human skeleton include:

1. It protects some delicate organs in the body, such as the heart, lungs, brain and spinal cord.
2. Together with the muscles, it brings about movement.
3. It provides support for the weight of the body.
4. It helps to bring about respiration.
5. Manufacturing of blood cells: Red blood cells and white blood cells are manufactured in the bone marrow of bones.

MUSCLES AND JOINTS

MUSCLES

Muscles are elastic tissues in the body that work in conjunction with the skeleton to bring about movement. They are attached to bones by tough tissues called tendons. Muscles generally perform two types of action, these are: contraction and relaxation.

Types of muscles

There are two types of muscles, these are:

1. Voluntary muscles. (Skeletal muscles)
2. Involuntary muscles. (Cardiac muscles)

Voluntary muscles are muscles we can move when we wish to move them. Examples are, biceps, triceps, calf muscles, pectoral muscles, deltoid muscles and other skeletal muscles.

Involuntary muscles are muscles that move of their own accord, and we have no control over their movement. Examples are the:

1. Smooth muscles which include:
    a. The muscles of the stomach wall
    b. The muscles of the blood vessels
    c. The muscles of the walls of the intestine
2. Cardiac muscles (muscles of the heart)

JOINTS

A joint can be defined as a place where two or more bones meet or articulate. Joints allow movement in our body. Bones in joints are attached each other by a hard or tough connective material called ligaments.

TYPES OF JOINTS

There are basically five types of joints. But these are grouped into two groups, namely:

1. Movable joints
2. Immovable joints or fixed joint

Movable joints

These are joints where movement of the body is possible. There are four types of movable joints. They are:

1. Ball and socket joint: This is a joint that permits movement in all direction. It can be found in the hip and shoulder.
2. Hinge joint: This is a joint that permits only a back and forth movement or a movement in one direction. It can be found in the knees, elbow, finger and toes.
3. Pivot joint: This is a joint that permits rotational movement and movements like nodding. It is found in the neck, between the Atlas and Axis vertebrae.

4. Sliding or gliding joint: This joint permits slight rotational movement. It can be found in the wrist, ankles, waist

Immovable joints

These are joints in which the bones are fixed over each other, thereby making movement impossible. An example of immovable joint is the suture joint found in the skull and pelvic girdle.

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DISEASES OF THE BONES

1. **Rickets:** This poorly developed bones. It is due to the lack of vitamin D in the diet especially in young children. It is therefore necessary to eat food which contains minerals and vitamins to ensure healthy growth and development of bones.
2. **Arthritis:** This disease affects the skeletal system. It is caused by inflammation of joints; during which the joints become swollen and painful.
3. **Rheumatism:** This is an inflammation of the muscles, tendons, joints, bones or nerves. It causes a lot of pain as well.

EXCRETION

Excretion is defined as the removal of waste products of metabolism from the cells and body of living organisms.

Excretory waste products are toxic or poisonous substance produced during metabolic processes in the body.

Excretion should not be confused with egestion or defecation. Egestion or defecation is the removal of undigested food materials out of the body through the anus.

METABOLISM

Metabolism is defined as the complete set of chemical reactions that occur in the body.

Waste products are produced during metabolism. These waste products are harmful to the cells of the body, if they are not removed out of the body.

There are two types of metabolism:

1. Anabolism
2. Catabolism

Anabolism involves the building up of compounds or materials in the body e.g. photosynthesis, growth.

Catabolism on the other hand involves the breaking down of complex compounds into simple forms or smaller substances e.g. respiration, digestion.

EXCRETORY ORGANS/STRUCTURES OF SOME ORGANISMS

S/No	Organisms	Excretory Organs or structures	Excretory products
1.	Unicellular organisms like Plasmodium e.g Amoeba, Euglena and Paramecium.	Contractile vacuole Body surface	Water, Ammonia and Carbon (iv) oxide
2.	Flatworms e.g Tapeworm	Flame cells	Nitrogenous wastes,carbon (iv)oxide,Ammonia and water.
3.	Annelids, e.g Earthworm	Nephridium (plural: Nephridia)	Nitrogenous wastes,urea,water and carbon (iv) oxide
4.	Insects,e.g Grasshoppers, Cockroach	Malpighian tubule	Uric acid
5.	Fish	Gills	Carbon (iv) oxide, water and urea

6.	Flowering plants	Stomata and lenticels	Carbon (iv) oxide, water vapour and oxygen. Other excretory products of plants are latex, gum, mucilage and turpentine from the back of plants. Others from the leaves = are alkaloids, cocaine and nicotine from tobacco.
7.	Man	Liver, Skin, Kidney, Lungs	Carbon (iv) oxide, water vapour, urea, sweat and bile. Excess amino acid

Importance of Excretion

i. To get rid of metabolic waste products out of the body.

ii. It helps to maintain a healthy environment in the body.

iii. Excretion helps to bring about the regulation of water in the body, otherwise known as osmoregulation.

iv. Excretion helps to bring about the maintenance of a constant internal environment in the body; also known as Homoestasis.

v. It helps in the maintenance of body temperature.

THE SKIN

The skin is the outer covering of the mammalian body. It is the part of the body that is subjected to tear and wear, and also the largest external organ of the body.

The mammalian skin is made up of two major layers:

i. Epidermis

ii. Dermis

1. **Epidermis:** This is the outermost part of the skin. It consists of the following parts:

a. **Cornified layer or horny layer:** It is the outermost layer of the epidermis. It makes the skin water proof, provides protection to the inner layer of the skin, prevents mechanical damage and the entry of pathogens into the body.

b. **Granularlayer:** It is the middle layer of the epidermis. It replaces the worn out tissues of the cornified layer.

c. **Malpighian layer or germinative layer:** It is the innermost layer of the epidermis. It consists of a pigment called melanin, which gives the skin its characteristic dark colour. It also contains active dividing cells.

2. **Dermis:** This is the innermost part of the skin. It is called the true skin because most of the important structures of the skin are found in the dermis. It consists of the following connective tissues:

a. **Sebaceous gland:** It secretes oily substance called sebum (skin oil) which keeps the hair water proof and the skin soft and moist.

b. **Blood vessels:** These carry blood rich in oxygen and food to the cells in the epidermis and dermis. They also remove waste products and help in the distribution of heat.

c. **Sweat gland:** This is a slender coiled tube that opens through the sweat duct and outside through the sweat pore. The sweat gland produces sweat and secretes it by passing it through the sweat duct to the sweat pores on the skin surface.

d. **Hair erector muscle:** These muscle help to keep the hair in position. When they contract, the hairs stand upright and when they relax, the hairs would be in a slant position.

e. **Hair follicle:** It's function is to build hair.

f. **Sensory nerve endings:** It helps in detecting stimuli like heat, pain, pressure, touch and cold, and transmit them to the central nervous system for interpretation.

How the Mammalian Skin Helps In Temperature Regulation

When the animal is hot, there will be excess heat in the body, the skin helps to regulate the body temperature in the following ways:

- The blood vessels close to the surface of the skin becomes wider, this is known as vasodilation. This makes more blood to flow to the surface of the skin.
- The sweat gland becomes more active and absorbs more water, salt and urea from the blood capillaries to produce more sweat; which comes out through the sweat pores on the skin and evaporates; bringing about a cooling sensation and lowering the body temperature.

iii. The hair erector muscles relaxes and the hair shaft slants on the skin causing heat to escape, thereby cooling the body temperature.

On the other hand, when the animal is cold, the temperature of the body reduces. The body temperature is regulated in the following ways:

i. The blood vessels close to the surface of the skin constricts (becomes narrow), this is known as vasoconstriction. This brings less blood to the surface of the skin, so that more heat is conserved inside the body.

ii. The sweat gland produces little or no sweat, to ensure that heat is retained in the body.

iii. The hair erector muscle contracts and the hair shaft stands erect causing layers of air to be trapped in the holes of the hair. The trapped air insulates the body and prevents heat from escaping from the body.

iv. Shivering occurs as a result of the contraction and relaxation of the muscles. This generates heat in the body which helps to raise the body temperature.

Note: Sweat contains water, salt and little urea.

Functions of the Skin

1. It excretes sweat.
2. It protects the internal body organs from mechanical injury.

3. It help to regulate the body temperature.
4. It is a sense organ, which responds to stimulus.
5. It manufactures vitamin D for the body.

THE KIDNEY

The kidneys are two bean-shaped organs situated in the abdominal cavity. They are connected to the bladder by two tubes called the left and right ureter.

The kidney has three layers, which are:

1. The outer layer cortex.
2. The middle layer called medulla
3. The inner layer called pelvis.

The major function of the kidney is to excrete urea, (a nitrogenous waste) out of the body. Urine is produced in the kidney nephron, it is a combination of salt, water and urea.

STRUCTURE OF THE KIDNEY.

A longitudinal section through the kidney shows the following:

1. The three layers: Cortex, medulla and pelvis.
2. The blood vessels: That is the renal artery (which brings blood rich in oxygen, food and waste materials to the kidney) and the renal vein (which takes filtered blood away from the kidney)

FUNCTIONS OF THE KIDNEY

1. The kidney serves as an excretory organ and is responsible for removing unwanted nitrogenous substances, e.g. urea from the body.
2. The kidney regulates the amounts of water and substances such as salts in the blood and in other cells of the body. This process is called Osmoregulation.

3. It plays a role in Homeostasis, which is the maintenance of a stable internal environment in the body.

KIDNEY DISEASES

Kidney diseases include the following:

1. Diuresis
2. Oedema
3. Kidney nephritis
4. Kidney stone

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DIAGRAM OF THE LONGITUDINAL SECTION OF THE KIDNEY.

THE URINARY SYSTEM

All waste materials produced from all over the body are carried in the blood through the renal artery to the kidney. The kidney purifies the blood by filtering out waste materials like urea, salt and water from the blood. These waste are converted to urine. The manufactured urine pass out of the kidney to the ureters, (two tubes that connect the kidneys to the bladder). From the ureter, urine is passed to the bladder. The bladder stores urine temporarily. When the bladder is filled or when the body can no longer hold the urine, the bladder contracts, causing urine to be passed out of the body through the urethra.

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DIAGRAM OF THE URINARY SYSTEM.

THE LIVER

The liver is a reddish brown organ located near the stomach. It is the largest internal organ of the human body. It plays a role in the removal of some waste materials from the body; such bile and excess amino acid.

OTHER FUNCTION OF THE LIVER

1. Regulation of blood sugar.

2. Detoxification: this is the breaking down and conversion of poisonous or toxic foreign substances that enter the body into harmless substances by the liver.
3. Deamination: this is the breakdown of excess amino acid into harmless urea, by the liver.
4. Production of bile.
5. Production of heat
6. Storage of vitamins and minerals.
7. Regulation of fats.
8. Formation of red blood cells in the young foetus.
9. Destruction of old red blood cells.

LIVER DISEASES

1. Diabetes mellitus.
2. Cancer of the liver.
3. Infective Hepatitis.
4. Cirrhosis of the liver.

RESPIRATION

Respiration can be defined as the process by which living organism take in and make use of oxygen in air to breakdown food in the body and produce energy for their day to day activities. It can also be defined as the breaking down or oxidation of glucose to release energy for the body's daily activities.

The process of respiration can be represented with chemical equation as follows:

$ssC_6H_{12}O_6 + 6O_2 \xrightarrow{\text{enzyme}} 6O_2 + 6H_2O + \text{Energy/ATP}$

It should be noted that Carbon (IV) oxide and water vapour are the two waste products produced during respiration.

Respiratory structure/organs in different organisms

Organisms	Respiratory organ/structure
Unicellular organisms, e.g. Amoeba, paramecium, chlamydomonas	Cell membrane or body surface
Earthworm	Moist skin
Fishes	Gills
Spider	Lung book
Amphibians e.g. toad	Mouth, moist skin, lungs, Gills
Insects	Trachea
Birds and mammals	Lungs
Plants	Stomata and lenticels

Phases of respiration

There are two phases of respiration. These are:

(i) Internal respiration

This is the phase of respiration that occurs inside the cells and tissues of living organisms. It can also be referred to as cellular respiration or tissue respiration. Energy is released from food during internal respiration.

(ii) External respiration

This is the phase of respiration that involves exchange of gases between the environment and the respiratory organ of living organisms. It is also known as breathing. External respiration involves the breathing in of oxygen in air into the respiratory organs and the breathing out of carbon (iv) oxide and water vapour to the atmosphere. It supplies oxygen needed to breakdown glucose during internal respiration, hence, it occurs before internal respiration.

Types of Respiration

There are two types of respiration, these are:

(a) Aerobic respiration

(b) Anaerobic respiration

(a) Aerobic respiration

This is the type of respiration which requires Oxygen to breakdown glucose into water, carbon (iv) oxide and energy. It can e represented by the chemical equation below:

$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{enzymes}} 6O_2 + 6H_2O$ + High amount of energy(ATP)

This type of respiration occurs in higher organisms like Goat, Man, Flowering plant, Cow and Monkeys.

(b) Anaerobic respiration

This is the type of respiration where glucose is broken down in the absence of oxygen to release energy, during anaerobic respiration, glucose is not completely broken down. In these, anaerobic respiration occurs during fermentation and germination of seed.

Fermentation is the process by which glucose is broken down to alcohol and carbon (iv) oxide by the help of enzymes in the absence of oxygen. It can be represented with the chemical equation below.

$C_6H_{12}O_6 \xrightarrow{\text{enzymes}} 2C_2H_5OH + 2CO_2$ + Little amount of energy

Anaerobic respiration also occurs in animal tissues, (like the muscles) during strenuous exercise, where glucose is broken down to lactic acid, water and little energy.

Uses of energy released during respiration

(i) It is used for growth

(ii) It is used for movement

(iii) It is used for the production of enzymes, protein and lipids

(iv) It is used during division.

Differences between Aerobic and Anaerobic respiration

	Aerobic respiration	Anaerobic respiration
i	Oxygen is required	Oxygen is not required
ii	It occurs in higher animal and plants.	It occurs in lower animal like yeast cell, bacteria etc.
iii	More energy is released	Less energy is released
iv	Glucose is completely broken down	Glucose is not completely broken down
v	It occurs in the mitochondrion	It occurs in the cytoplasm

Similarities between Aerobic and Anaerobic respiration

(i) Both occur in living cells.

(ii) Enzymes are involved in both.

(iii) Glucose is broken down in both.

(iv) Both reaction produce by products.

(v) Energy is released in both.

Mechanism of external respiration or breathing

Breathing or external respiration involves the taking in of air, also known as inspiration or inhalation, and the breathing out of air known as expiration or exhalation.

Inspiration/Inhalation/breathing in:

This is the process of taking in or air rich in oxygen from the surrounding into the lungs. When we breathe in air or during inhalation, the following occurs:

(a) The diaphragm contract and becomes flat
(b) The rib cage moves upwards and outwards
(c) The intercostal muscles contract
(d) The volume of the chest cavity increases and the pressure inside the chest cavity reduces.
(e) Air enters the lungs through the nostrils to fill the alveoli (tiny airsacs inside the lungs).

Expiration/exhalation or breathing out:

This is the removal of air rich in carbon (iv) oxide and water vapour from the lungs to the outside environment. The following occurs during exhalation;

(a) The diaphragm relaxes and returns to its original dome-shape (curved shape).
(b) The intercostal muscles relax
(c) The ribcage move downwards and outwards
(d) The volume of the chest cavity decreases and the pressure in the chest cavity increases.
(e) Air is forced out of the lungs and expelled through the nostrils

The Human Respiratory System

Live a page for diagram of human respiratory system

Organs involved in the respiratory system

1. Nose:

These are two nostrils, through which air rich in oxygen enter the lungs and air rich in carbon (iv) oxide is expelled out of the body.

2. Pharynx

This is an open space that leads to the larynx. It also known as the throat.

3. Larynx

It is the pipe that connects the nostrils to the trachea. It is also known as voice box.

4. Trachea or wind pipe:

These are air two tubes that enter the lungs, inside the lungs it branches (or divides) into smaller tubes called bronchioles. The bronchioles lead into numerous tiny sac-like structures called Alveoli.

The wall of the trachea and bronchi are made of cartilage, which prevents them from collapsing when the pressure inside them is low.

5. Alveoli (singular: Alveolus):

These are tiny air sacs found inside the lungs. The Alveoli is the site or place where gaseous exchange takes place.

Air pathways

Nostrils → Nasal Cavity → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Alveoli

Gaseous Exchange in Man

Gaseous exchange in man involves the exchange of gases between the alveoli and the blood capillaries that surrounds them; during which oxygen in the alveoli diffuse into the blood capillaries and carbon (iv) oxide in the blood capillaries diffuse into the alveoli. The oxygen is transported round the body to the cells and tissues and is used breakdown glucose to release energy while

the carbon (iv) oxide is excreted out of the body by the respiratory system, through the nose.

Some diseases of the respiratory system

1. Asthma:

   This is a disease of the trachea. The lining of the trachea of an asthma patient is usually swollen and this disturbs the free flow of air, especially during breathing out.

2. Emphysema

3. Common cold and catarrh

   This is caused by a virus. It results in difficulty in breathing due to the accumulation of watery mucous in the nostrils.

4. Pneumonia

   This is a disease of the lungs in which the delicate lungs tissue is affected. It caused by bacteria. It is a very serious disease because any serious damage to the lungs can result in death. Pneumonia patients usually find breathing difficult since it is accompanied by pain in the chest.

5. Tuberculosis

   This is caused by bacteria. It can lead to destruction of the lungs

6. Hay fever

   It occurs when we inhale pollen grains and other particles into the nostrils. It results in sneezing

7. Bronchitis

8. Cancer of the lungs
9. Silicosis

CIRCULATORY SYSTEM

The circulatory system is the pathway through which blood and other materials are carried to different parts of the body where they are needed. It is also known as transport system.

The circulatory system consists of the following

(a) Heart
(b) Blood
(c) The blood vessels. That is veins, Arteries and Capillaries

Types of circulation in man

The type of circulation in man is known as double circulation. In this type of circulation, the blood enters into the heart twice for every complete circulation.

Double circulation occurs in two stages:

1. Pulmonary circulation
2. Systemic circulation

Pulmonary circulation

This is the flow of deoxygenated blood from the right ventricle of the heart to the lungs through the pulmonary artery, and the flow of oxygenated blood from the lungs back to the left auricle of the heart through pulmonary vein. During pulmonary circulation, deoxygenated blood flow to the lungs where it takes up oxygen and becomes oxygenated, before returning back to the heart.

Systemic circulation

This is the flow of oxygenated blood from the left ventricles of the heart to all parts of the body through the aorta and the flow of deoxygenated blood back to the right auricle of the heart from all parts of the body through the vena cava. During systemic circulation, oxygenated blood from the heart is taken to all parts of the body where the body cells use up the oxygen to break down glucose, in order to release energy.

The blood

The blood is a suspension of cells in aqueous solution. It is a living tissue that flow through all parts of the body transporting various materials that are dissolved or suspended in it.

Components of the Mammalian Blood

The mammalian blood is made up of the following:

(a) Plasma
(b) Blood cells or corpuscles: there are two types of blood cells. These are:
    (i) Red blood cells or Erythrocytes
    (ii) White blood cells or leucocytes
(c) Platelets or thrombocytes

Blood Plasma

This is a pale-yellow liquid. It contains about 90% of water, while other substances dissolved in it make up the remaining 10%. The dissolved substances in the plasma include:

(a) Digested food; such as glucose, amino acids and fatty acids.
(b) Mineral salts; such as potassium and calcium phosphates, sodium and magnesium chlorides
(c) Vitamins

(d) Gases such as oxygen carbon dioxide and nitrogen
(e) Waste products such as urea
(f) Hormones
(g) Antitoxin and antibodies
(h) Blood proteins such as albumin, globulin, prothrombin and fibrinogen

Functions of the Blood Plasma

i. It transports all the substance dissolved in it.
ii. It carries the blood cells

Red Blood Cells

The red blood cells also called erythrocytes are small biconcave or disc shaped cells found in the blood. They have a life span of 90 to 120 days. The red blood cells are produced in the bone marrow and when they are old; are destroyed in the liver and spleen. Red blood cells is to transport oxygen round the body.

The Red blood cells contain an iron pigment or protein called Haemoglobin. The haemoglobin is the red pigment in the Red blood cells that combines with oxygen to form oxy-haemoglobin (the form in which oxygen is transported in the body), Haemoglobin gives the blood its characteristics red colour.

White Blood Cells

White blood cells, also known as leucocytes are shapeless transparent blood cells that contain nucleus. They are formed in the lymphatic nodes and bone marrow they are larger than red blood cells and fewer in number. The function of white blood cells is to defend and protect the body against pathogens and diseases.

There are two types of white blood cells there are:

(a) Phagocytes or granulocytes: These are white blood cells that attack harmful foreign organisms or pathogens in the blood by surrounding them and destroying them.
(b) Lymphocytes or Agranulocytes: These are white blood cells that produce chemical substances called antibodies and antitoxins which attack and destroy toxins (poisons) of bacteria in the blood

Platelets

General are not cells but tiny structures in the blood which do not have nucleus. They are also formed in the bone marrow. They aid in blood clotting; hence, preventing continuous bleeding; also though blood clotting, bacteria are prevented from entering our body through wounds.

Functions of blood

Generally, there are two main functions of blood: transport and defense. These can be split as follows:

(a) Transportation of digested food such as glucose, amino acid from the small intestine to the various parts of the body.
(b) Transportation of oxygen from the lungs to all parts of the body.
(c) Transportation of carbon dioxide, urea and other waste products from the body cells to the excretory organs
(d) Transportation of hormones from their point of secretion to the target organs
(e) The platelet in the blood prevents loss of blood from bleeding by clotting.
(f) Distribution of heat uniformly to all parts of the body, hence maintaining the body temperature.
(g) White blood cells in the blood help to defend the body against diseases.

Blood Diseases

These are diseases that affect the circulatory system. They include:

(a) Anaemia
(b) Sickle Cell Anaemia
(c) High blood pressure
(d) Stroke
(e) Leukemia (Blood cancer)
(f) Coronary thrombosis
(g) Malaria

ANAEMIA

This is a condition in which the total amount of red blood cells in the blood is greatly reduced. It may be caused from excessive bleeding, unusual destruction of red blood cells by parasites (e.g. malaria parasite, plasmodium); or deficiency of iron in the blood. Anaemia is not regarded as a disease but a symptom of other diseases.

SICKLE CELL ANAEMIA

This is a hereditary disease. It is a special case of Anaemia in which the red blood cells becomes sickle in shape. A sickle-shaped red blood cell easily breaks up and their life span is short. The sickle cells result from the displacement of the soluble normal haemoglobin which has high affinity for oxygen with a less soluble abnormal haemoglobin which has reduced or less affinity for oxygen. Victims of sickle-cell Anaemia suffer severe pains at the joints due to shortage of oxygen and many collapses and die if they do strenuous exercise.

LEUKEMIA

This is a blood cancer. It is a serious blood disease which results in the over production of white blood corpuscles. This disease may result from the over

exposure of the body to radioactive particles or X-rays. Early signs of the disease include weakness, anaemia or bleeding.

Blood Group and Blood Transfusion

Blood Group

There are four main types of blood groups in man. The blood groups depend on the types of antigen carried by the red blood cells. Antigens are substances found on red blood that induce the production of antibody in the body. There are two types of antigens. They are:

(a) Antigen A
(b) Antigen B

The plasma carries antibodies. Antibodies are chemical substances which attack and destroy toxins of bacteria and other germs in the body. There are two types of antibodies, they are:

(a) Anti a antibody
(b) Anti b antibody

Blood Group	Antigens in red Blood cell	Antibody in Blood plasma	Can donate to	Can receive from
A	A	b	A, AB	A, O
B	B	a	B, AB	B, O
AB	A and B	none	AB	AB, A, O, B
O	None	a and b	A, B, AB and O	O

Blood group O is called a universal donor, because it can donates to all other blood. While blood group AB is called universal recipient because it can receive from all blood groups

If a person has a particular antigen, he cannot have the same antibody; otherwise, clumping of blood will occur. Clumping of blood leads to the blockage of blood vessels. The clumping of the red blood cells as a result of using the wrong blood group is known as agglutination

Blood Transfusion

This is the transfer of blood or blood products from one individual to another. Before blood transfusion, it is very important to carry out blood tests on both the donor and the recipient. The reasons for these are:

(a) To prevent mixing of wrong blood groups, which can leads to agglutination and eventually death.
(b) To prevent transfusion of deadly diseases like HIV, Hepatitis etc.
(c) To determine the genotype (either AA, AS, SS) of the parent in order to reduce the risk of sickle cell anaemia.

Blood Vessels

Blood Vessels are tubes through which blood circulate round the body. There are three major types of blood vessels, these are:

(a) ARTERIES

These are blood vessels that carry blood away from the heart. They have thick elastic walls made of muscles. The largest artery is called Aorta, and smallest artery is called Arteriole.

(b) VEINS

These are blood vessels that carry blood back to the heart. They have, thin, non-elastic walls also made of muscles. The largest vein is called vena cava and the smallest is called Venule.

(c) CAPILLARIES

These are tiny blood vessels that link arteries to veins. They are one-cell thick and are permeable to materials.

DIFFERENCES BETWEEN ARTERIES AND VEINS

Arteries	Veins
Carry blood away from the heart	Carry blood back to the heart.
Blood in arteries flow with high pressure	Blood in veins flow with low pressure
They have thick elastic walls	They have thin non-elastic walls
They have narrow lumen	They have wide lumen
Pulse is present	Pulse is absence
Arteries carry oxygenated blood, except the pulmonary artery	Veins carry deoxygenated blood, except the pulmonary veins
Arteries are found inside the body	Veins are found at the surface of the body
Valves are absent in arteries	Valves are present in veins

THE HEART

The heart is the most powerful organ in the circulatory system it is situated in the thorax under the sternum. It is made up of cardiac muscles. It is conical in shape, reddish in colour and enveloped in a thin membrane called pericardium.

The main function of the heart is the pumping of blood to all parts of the body, thereby keeping the blood in continuous circulation.

The hearts has four chambers, namely;

(1) The two upper chambers called
    (a) The right auricle or atrium
    (b) The left auricle or atrium
(2) The two lower chambers called
    (a)The right ventricle
    (b) The left ventricle

The right side of the heart contains deoxygenated blood, while the left side of the heart contains oxygenated blood. The right and left sides of the heart are separated by a thin muscular wall called septum. The septum prevents or avoids the mixing up of blood (oxygenated blood and deoxygenated blood).

The heart has valve between the auricles and the ventricles. The valve between the right auricle and right ventricle is called the tricuspid valve, while the valve between the left auricle and left ventricle is called the bicuspid valve. The valves prevent the back-flow of blood, thereby allowing the flow of blood in one direction.

HEART BEAT

Each pumping action of the heart is known as heartbeat. An average man has 72 heart beat per minute when he is at rest, but when he is running or during exercise, it increases to 100 or more per minute. Heart beat occurs as a result of the contraction and relaxation of the four muscular chambers of the heart and it involves two stages, which are:

(a) Diastole: this is when the auricles are contracting and the ventricles are relaxing. It is the relaxation phase of heart beat.
(b) Systole: This is the contraction phase of heart beat, during which the ventricles contract to pump blood into the arteries and auricles relax,

DIGESTIVE SYSTEM

This is the system in the body that is concerned with the breaking down of food into smaller particles that can be absorbed by the body.

Feeding is an important process that must be carried out in order for living organisms to stay alive and to carry out important life functions. The process of feeding in humans involves the following processes:

- Ingestion: It is the taking in of food through the mouth cavity.

- Digestion: Digestion is defined as the process by which complex food particles are broken down by the aid of enzymes into smaller simpler forms which can be absorbed into the blood stream.
- Absorption: it is the taking in or diffusion of the digested food through the walls of the intestine into the blood stream
- Assimilation: it is the use of digested food substances to release energy for daily activities.
- Egestion: it is the removal of undigested waste products of digestion through the anus.

THE HUMAN DIGESTIVE SYSTEM

The human digestive system consists of the following parts:

- Mouth or Buccal cavity 2. Gullet or Oesophagus 3. Stomach 4. Small intestine (which consists of the Duodenum, Jejenum and Ileum) 5. Large intestine 6. Rectum 7. Anus

MOUTH/BUCCAL CAVITY

The mouth contains structure such as teeth, tongue and salivary gland.

Teeth: it breaks down the food particles into simple particles through chewing, grinding, and crushing for easy swallowing. By doing this, it exposes the food to a large surface area for enzymes to act on it.

The salivary gland: it produces or secretes saliva, which softens food and makes swallowing easy. The saliva contains enzymes called Ptyalin which helps in the digestion of cooked starch in the mouth.

The tongue: it mixes the food with saliva and rolls the food to a bolus, then the food is swallowed.

OESOPHAGUS/GULLET

The Oesophagus connects the mouth to the stomach. The softened food is passed to the stomach through a wave-like contraction of the muscles of the Oesophagus called PERISTALSIS.

STOMACH

In the stomach the food is mixed up due to the rhythmic contraction and relaxation of the muscular walls of the stomach, this process is called CHURNING.

The digestion of protein starts in the stomach. The food is stored for two to four hours here and is released at regular interval.

The walls of the stomach is made up of glands called Gastric gland which secretes gastric juice

The gastric juice contains the following:

- Two digestive enzymes called Pepsin and Rennin.
- Dilute Hydrochloric acid (HCl)

Pepsin helps in digestion of protein. It converts protein to peptones. Rennin helps in coagulation of soluble milk protein called caseinogen into insoluble thick curds called casein. These two enzymes work in acidic medium.

FUNCTIONS OF HYDROCHLORIC ACID (HCl)

- It stops the action of ptyalin
- It sterilizes the content of the stomach by killing the harmful bacteria in food.
- It stops the food from decaying since it is in an acidic medium.
- It provides the best medium for the action of Renin and Pepsin.

After the action of pepsin and rennin, the food at this time is now paste-like form called CHYME.

The Chyme is passed to the DUODENUM by peristalsis action.

DUODENUM

This is the first part of the small intestine. Two alkaline digestive juices or secretionsare added to the food in the duodenum. They areBile and Pancreatic juice produced by the pancreas

BILE:

Bile is a greenish-yellow alkaline secretion produced by the liver and stored in the gall bladder. It flows into the duodenum through the bile duct when the need arises.

FUNCTIONS OF BILE

- It help in the emulsification of fat and oil. Emulsification is the breaking down of fat and oils to tiny droplets, so that the enzyme lipase can act on them.
- It contains high percentage of water, which is added to Chyme.
- It neutralizes the action of the HCl acid in chyme, hence restoring the alkaline medium needed for the working of the enzymes in pancreatic juice.

PANCREAS

The pancreas is found near the duodenum. It secretes a watery alkaline liquid called pancreatic juice. This juice contains the major important enzymes that account for digestion of starch, protein and fats. The enzymes are:

- Amylopsin: that acts on the remaining starch converting them into maltose sugar.
- Trypsin: convent peptones into polypeptides
- Pancreatic Lipase: convert emulsified fat and oil into fatty acid and glycerol

  The food when leaving the duodenum is now watery in nature and is known as Chyle.

JEJENUM

This is the second part of the small intestine. Nothing takes place in the here. The food just passes.

ILEUM

It is the longest part of the alimentary canal. The intestinal gland found in the walls or lining of thesmall intestine secretesintestinal juice. The juice contains three digestive enzymes that complete the digestion of food. The enzymes are:

a. Maltase: it converts Maltose to Glucose + Glucose

b. Lactase: it converts Lactose to Glucose + Galactose

c. Sucrase:it converts Sucrose to Glucose + Fructose

2. Lipase: it converts fats and oil to Fatty acid (or carboxylic acid) and glycerol.

3. Erepsin: it converts polypeptides to amino acid.

Digestion of food is completed in the ileum. The end products of digestion are glucose for carbohydrate; amino acid for protein; fatty acid and glycerol for fat

and oil. Vitamins, mineral salts and water are absorbed directly into the blood stream without passing through the process of digestion.

The digested food is absorbed into the blood stream through finger like structures found on the walls of the ileum of the small intestine called Villi (singular: villus).The absorbed food in the blood are carried to the liver by the hepatic portal vein. The liver regulates the amount of food that will go into the blood by storing some part of the food and releasing the needed amount into the blood. It also screens the food for toxic substances. From here, the food can now be assimilated. After assimilation, excess glucose is converted to glycogen and stored in the liver. Excess amino acid are not stored but converted into urea by the liver (deamination), which is excreted out through the kidney. Excess fat are deposited in the fat storage cells of the body called adipose tissues which are found at the thighs, abdomen, and buttocks muscles and underneath skin, some excess carbohydrates or starch are also changed to fat.

LARGE INTESTINE

No digestion occurs here, except that food materials that are not absorbed or that are undigested (feaces) are stored here temporarily before getting egested out through the anus. However, water is reabsorbed from the undigested food at the Rectum, before egestion from the anus.

TABLE SHOWING SUMMARY OF DIGESTION AND THE ENZYMES INVOLVED

Enzymes	Source	Location	Medium	Food	End product
Ptyalin	Saliva	Salivary gland (mouth)	Alkaline	Cooked starch	Maltose
Renin	Gastric	Gastric	Acidic	Milk protein	(Casein) or

	juice	gland (stomach)		(Caseinogen)	thick curd
Pepsin	Gastric juice	Gastric gland (stomach)	Acidic	Proteins	Peptones
Lipase	Pancreatic juice	Duodenum	Alkaline	Emulsified fats and oil.	Fatty acid and Glycerol
Amylase	Pancreatic juice	Duodenum	Alkaline	Starch	Maltose
Trypsin	Pancreatic juice	Duodenum	Alkaline	Peptones	Polypeptides
Erepsin	Intestinal juice	Ileum	Alkaline	Polypeptides	Amino acid
Maltose	Intestinal juice	Ileum	Alkaline	Maltose	Glucose + Glucose
Sucrase	Intestinal juice	Ileum	Alkaline	Sucrose	Glucose+ Fructose
Lactase	Intestinal juice	Ileum	Alkaline	Lactose	Glucose+ Galactose
Lipase	Intestinal juice	Ileum	Alkaline	Emulsified Fat and oil	Fatty acid and glycerol