

1. CELLS AND TISSUES

INTRODUCTION

Anatomy: Study of different parts of human body and their relationship to one another.

Physiology: Study of the functions of the body and the various systems present within.

Systems of human body:

The human body is made up of different systems to perform different functions. They are:

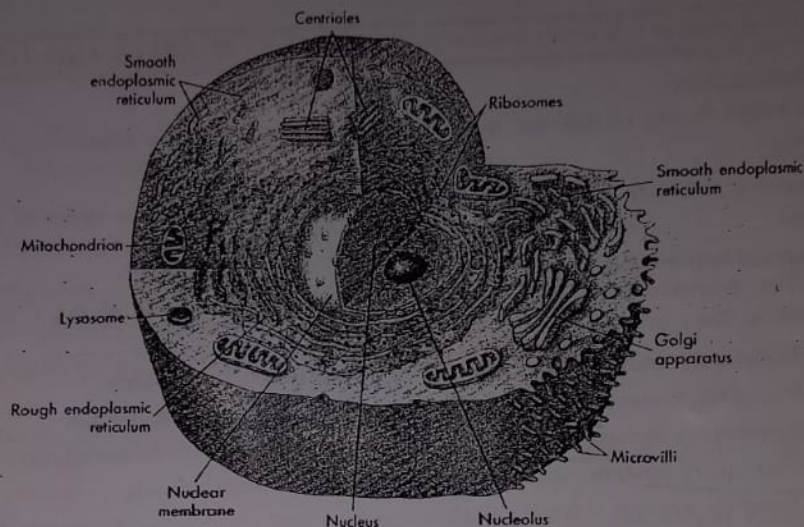
1. Skeletal system - dealing with bones and joints of human body.
2. Muscular system - dealing with skeletal muscles and their function
3. Respiratory system - dealing with the organs responsible for breathing.
4. Circulatory system - dealing with heart and the blood vessels.
5. Digestive system - dealing with the organs and associated glands involved in the digestion of food.
6. Urinary system - dealing with the organs involved in the excretion of urine.
7. Genital system - dealing with the organs of reproduction
8. Endocrine system - dealing with ductless glands and their functions.
9. Nervous system - dealing with brain, spinal cord and the structures responsible for specialized functions like touch, taste, smell, vision and hearing.

Cell:

Cell is the **structural** and **functional** unit of the human body. Many cells of a similar structure and function together form a **tissue**. A number of tissues unite together to form an **organ**. Organs groups are together to form a **system**. Cells are of many types. They perform functions specific to the tissue. The cells of the nervous system and glands like liver and endocrine glands perform highly specialized functions.


Structure of Cell:

A cell consists of centrally placed **nucleus**. Surrounding the nucleus is a jelly like mass known as **cytoplasm**. The cytoplasm along with nucleus is called **protoplasm**. Protoplasm is covered by cell wall which is made up of fats, proteins and small amount of carbohydrates.



Organelles of Cytoplasm:

Cytoplasm contains many structures, each performing different functions.

Mitochondrion - It performs respiration and catabolism. It is the chief source of energy in cell and hence called as powerhouse of the cell. 

Golgi apparatus - These are concerned with the addition of carbohydrate to protein.

Endoplasmic reticulum - These are membrane bound tubules. On the surfaces of endoplasmic reticulum the ribosomes are present.

Ribosomes - They contain RNA (ribo nucleic acid), which is involved in the synthesis of proteins. They may remain free in the cytoplasm or associated with endoplasmic reticulum.

Lysosome - It contains various hydrolytic enzymes, which are involved in the intracellular digestive process.

Mitochondria
Golgi apparatus, Endoplasmic reticulum, Ribosomes and Lysosomes together form **GERL** complex concerned with the synthesis of proteins.

Centrosome - It is vital for cell division.

Nucleus:

Nucleus is a mass of protoplasm surrounded by a nuclear membrane. It has thread like structures known as chromosomes.

Chromosomes contain genetic material, which is responsible for hereditary characters of an individual. Normally 23 pairs of chromosomes are present in body cells. 22 pairs of them are known as autosomes and one pair of sex chromosomes called allosomes. In the female a pair of X chromosomes are present and in male an X and Y chromosomes are present.

DNA and RNA

DNA - It is known as deoxyribonucleic acid. It is seen in the chromosomes. DNA is the carrier of genetic information. It is made up of a sequence of nitrogenous molecular sub units.

RNA - It is known as ribonucleic acid. It is found in both nucleus and in the cytoplasm. It is also made up of nitrogenous molecular sub units. It transmits genetic instructions from nucleus to cytoplasm. In the cytoplasm, RNA takes part in the synthesis of proteins.

FUNCTIONS OF THE CELL

1. Ingestion and assimilation: *Receives*

Cells get their nutrition through the cell wall from the intercellular fluid and convert simple amino acids into proteins.

Anabolism - The ingested material by the cell is assimilated which is used to synthesize the protoplasm and to repair or replace dead or injured cells. This process of growth and repair of cells is called anabolism.

Catabolism - Cells require energy to live and perform a function. So, some of the food materials are broken down to get energy. This process is known as catabolism.

Metabolism - The process of anabolism and catabolism go on simultaneously in the body. Together the catabolism and anabolism will be known as metabolism. End products of metabolism are called as metabolites.

2. Respiration:

This process takes place mainly in the mitochondria of cells.

3. Excretion:

The waste products produced by the catabolism and the cells to the extra cellular fluid eliminate respiration. From the extra cellular fluid they are excreted by kidney and skin.

4. Excitability and Conductivity:

Tissues respond to physical, mechanical and chemical stimuli. The response may be contraction (i.e. in muscle), production of secretions (i.e. in the glands) and conduction of an impulse (i.e. in nerve cells).

TISSUES

As mentioned earlier many cells of a similar structure and function together form a **tissue** with the help of intercellular cementing substance. Tissues of body can be divided into **four** types. They are,

a) Epithelial tissue b) Connective tissue c) Muscular tissue d) Nervous tissue

Epithelial tissue:

It covers the surfaces of the body (e.g. skin) or forms the inner lining of hollow organs (e.g. stomach, uterus, urinary bladder etc.,)

Connective tissue:

Connective tissue binds and connects other tissues and provides a supporting framework to the body wall. There are different types of connective tissues present in the body.

- a) Cartilage b) Bone c) Blood d) Neuroglia

Muscular tissue:

It is specialized for contraction. They bring about body movements.

Nervous tissue:

It is a specialized tissue for coordinating the activities of the body.

QUESTIONS

1. Draw a labeled diagram to show the organelles of a cell.
2. Name the different types of tissue and their function.



2. SKIN

Skin is the outer covering of the body and continues with the mucous membrane at all the openings of the body.

Structure of skin:

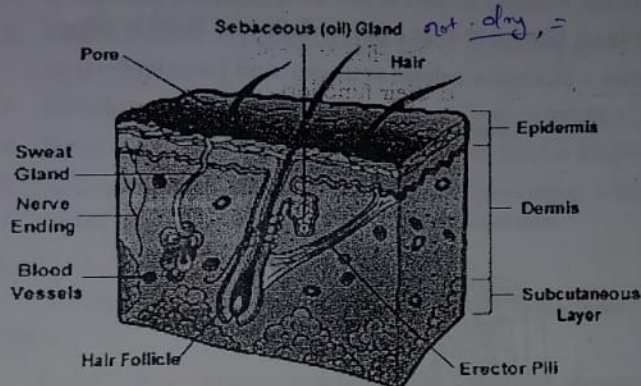
It consists of two layers known as outer epidermis and an inner dermis.

Epidermis is made up of multiple layers of epithelium.

Dermis

It contains hair follicles, melanin pigments, capillaries, nerve endings, sweat glands and sebaceous glands.

Sweat glands are more in palm and sole of foot. About 500 ml of sweat is formed in 24 hours.



Functions of skin:

1. Protects underlying structures from injury.
2. Excretes salts and metabolites like urea.
3. Regulates body temperature.
4. Synthesizes vitamin D.
5. Secretes sweat and sebum, which keeps the skin oily and prevents from drying.
6. Largest sensory organ of the body.

QUESTION

1. Name the functions of skin.



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3. BONES AND JOINTS

Bones and joints form skeletal systems which performs the following functions:

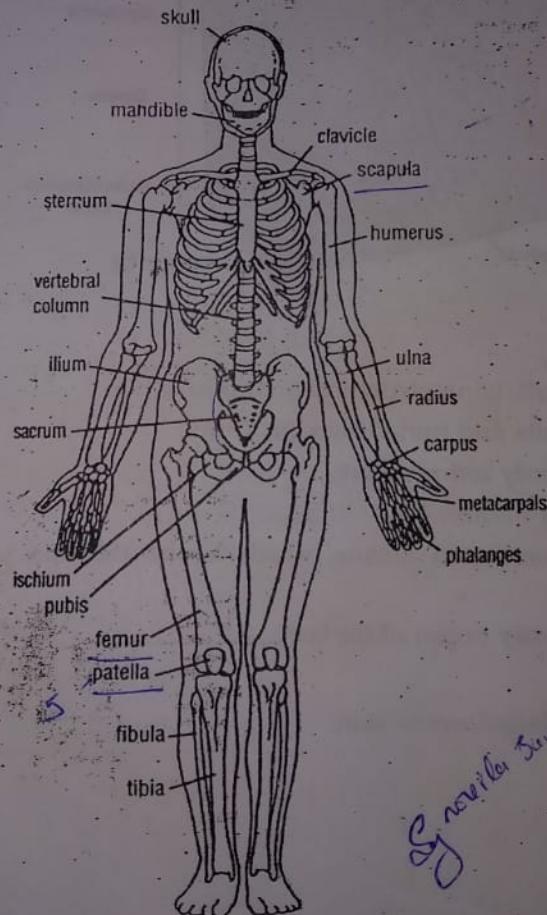
1. It provides shape and support for the body and protects vital organs like brain.
2. It gives attachment to muscles to help the joints of the body to perform different movements.
3. Red bone marrow found within the bones produce Red blood cells.
4. Minerals like phosphorus and calcium are stored in bones.

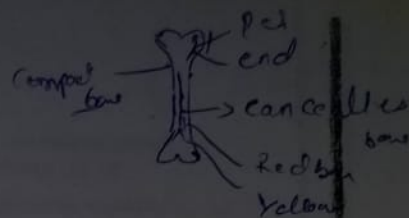
Classification of skeleton:

Skeleton can be divided into axial and appendicular skeletons.

Axial skeleton – skeleton related to axis of the body is known as axial skeleton. It consists of skull, vertebrae, thoracic cage (ribs), pelvis and hyoid bone.

Appendicular skeleton – skeleton related to upper and lower limbs.





BONES:

Compact bone is the dense portion found on the surface

Cancellous bone is the spongy part present within the layers of compact bones.

Bone marrow is the soft material in the bony cavity.

Two kinds of bone marrows are present.

1. Yellow bone marrow formed by fatty tissue.
2. Red bone marrow, which takes part in the formation of cells of blood.

Membrane covering the outside of the bone is **periosteum** and the membrane covering the inside of the bone around its cavity is **endosteum**

CLASSIFICATION OF BONES

Bones are classified as

1. **Long bones** – bones having two end with a body (shaft). e.g. limb bones like femur and humerus
2. **Short bones** – bones do not have specified parts like body and ends. e.g. wrist bones
3. **Flat bones** – are flat in appearance. e.g. scapula, ribs etc.
4. **Irregular bones** – do not have any particular shape. e.g. vertebrae
5. **Seasamoid bones** – small bones developed within tendons. e.g. patella (Knee cap)

SKULL:

It forms the framework of head. Individual bones of skull are joined by Sutures.

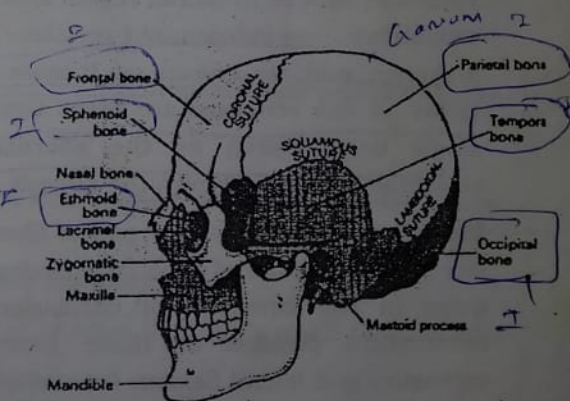
The skull has many openings for the passage of nerves and blood vessels and these are known as foramina. Largest foramen in the skull is the foramen magnum through which medulla oblongata of the brain comes out and continues as spinal cord in the vertebral canal. Skull bones are grouped in two parts known as cranium and facial skeleton.

Cranial skeleton:

All the bones of the cranium are connected by Sutures (immovable joints) to form the brain box to protect the brain.

The following are the 8 cranial bones:

- | | |
|----------------|----|
| • Frontal bone | -1 |
| • Parietal | -2 |
| • Temporal | -2 |
| • Occipital | -1 |
| • Sphenoidal | -1 |
| • Ethmoidal | -1 |



Facial skeleton:

It is made up of 14 bones. Except mandible all other bones are united by Sutures and mandible is the only movable bone in the skull.

Bones of the face are paired Nasal, Palatine, Lacrimal, Zygomatic, and inferior concha, Maxilla and single Mandible and Vomer.

Sinuses in skull bones:

There are spaces (air sinuses) in skull bones. Since these spaces are situated in the bones surrounding nose namely frontal, ethmoid, sphenoid and maxilla, they are called paranasal air sinuses. These sinuses open into the lateral wall of nose.

These air sinuses help to lighten the weight of the skull, give resonance to the voice and help in giving shape to the face.

Frontal air sinus - lies above the root of nose.

Sphenoid sinus - lies behind the nose

Ethmoidal sinuses - lie on either side of nose

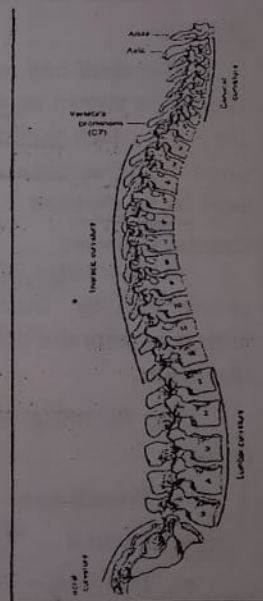
Maxillary sinus - lie below and on each side of nose.

Sinusitis - Inflammation of mucosa of paranasal air sinuses is known as sinusitis. Cilia on surface of mucus membrane of these sinuses help in the drainage of secretion. In smokers these cilia are destroyed so, they suffer more easily from sinusitis. Since, mucosa of maxillary sinus and upper teeth are supplied by the same nerves i.e. branches of maxillary nerve the inflammation of maxillary air sinus is usually accompanied by toothache.

VERTEBRAL COLUMN

The **vertebral column**, which is 60 to 70 cm in length, in adult, is made up of 33 vertebrae. Out of these 24 are movable independent vertebrae and remaining 9 are fused to form 2 bones. Seven independent vertebrae that lie in neck region are called **cervical vertebrae**. Twelve independent vertebrae that lie in thorax region are called **thoracic vertebrae**. Five independent vertebrae that lie in the abdomen and are known as lumbar vertebrae. In pelvis all five vertebrae are fused together to form a single bone known as the **sacrum** and last 4 vertebrae also fuse to form the coccyx.

Intervertebral disc - is a pad of fibro cartilage that lies between bodies of each independent vertebra and helps in the formation of cartilaginous joint. The movements possible at these joints are flexion, extension and lateral flexion. Intervertebral disc is the one that is involved in the condition called disc prolapse.



disk
intervertebral
disk

8 -> Strengthen

Thoracic cage:

Skeleton of thorax is made up of bone and cartilage. 12 thoracic vertebrae at back, 12 pairs of ribs at the sides and the sternum in front.

Sternum - It has three parts manubrium, body and xiphoid process. The notch felt at the upper end of sternum is known as jugular notch.

Ribs - There are twelve pairs of ribs and they all slope downwards from back to front.

All the ribs articulate with the thoracic vertebrae at the back. In front the upper seven ribs are attached to sternum directly by their cartilages. These are true ribs. The eighth, ninth and tenth are attached to the sternum indirectly by attaching their cartilages to the 7th cartilage. These are known as false ribs. The eleventh and twelfth ribs are not attached with sternum and are known as floating ribs.

Vertebrae - 12 thoracic vertebrae form the thoracic portion of the vertebral column and lie at back.

Bones of upper limb:

Bones of upper limb are attached to the trunk by shoulder girdle.

Shoulder girdle consists of a scapula and clavicle. Clavicle is called the collarbone. Scapula is known as shoulder blade.

Upper limb can be divided into arm, forearm and hand.

Humerus is the bone of the arm

Radius on lateral aspect and ulna on medial aspect are the bones of forearm.

Wrist is made up of eight small bones known as carpal bones arranged in two rows.

In the proximal (upper) row they are from without inwards scaphoid, lunate, triquetral and pisiform. In the distal (lower) row they are from without inwards trapezium, trapezoid, capitate and hamate.

Hand has five metacarpal bones.

Fingers or digits - there are 14 phalanges three in each finger and two on the thumb.

Bones of lower limb:

Lower limb bones are connected to the trunk by pelvic girdle. It is formed by sacrum, coccyx and two hipbones.

Lower limb can be divided into thigh, leg and foot.

Thigh-bone is known as femur. In front of knee there is a small bone known as patella (knee cap). It is a sesamoid bone.

In leg two bones are present known as tibia medially and fibula laterally

In foot there are 7 tarsal bones seen around ankle joint and they are calcaneum, talus, navicular, cuboid and three cuneiforms.

5 metatarsal bones are seen in the middle of foot

14 phalanges form the bones of digits as in the hand.

Joints:

The meeting place of two or more bones is called as joints. Study of joints is known as arthrology.

Classification:

Joints are classified as following by their movements

1. Fibrous joints
2. Cartilaginous joints
3. Synovial joints

Fibrous joints – they are immovable joints. Here the participating bones show tight union between them and usually no movement is possible. e.g. sutures of skull, teeth and sockets

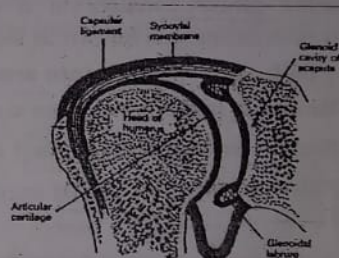
Cartilaginous joints – these are slightly movable joints. A pad of fibro cartilage is present in between the articulating bones. e.g. pubic symphysis and inter vertebral disc.

Synovial joint – these are freely movable joints.

These joints show characteristics such

as:

1. Participating bones are connected by ligaments.
2. Joint is enclosed by synovial membrane.
3. The joint cavity presents synovial fluid.



Synovial joint can be further subdivided into the following based on the morphology of articulating surfaces.

Plane joints – two flat surfaces meet. e.g. inter carpal and inter tarsal joints.

Hinge joints – in this joint movement is possible in one plane only. e.g. elbow joint

Pivot joints – this joint allows only rotation movements e.g. upper radio ulnar joint *ulna Radius*

Ball & socket – this type shows the movement in all directions. e.g. shoulder joint

Condylloid joint – this joint allows movements in two planes. e.g. temporomandibular joint.

Saddle joint – has a concavoconvex articular surface and hence movements occur in all directions. e.g. thumb.

All joints of upper and lower limbs are synovial joints except inferior tibiofibular joint. Wherever movement is required the joints are synovial.

Joints of upper limb:

Sternoclavicular joint - it is a plane joint. It is a joint between sternum and clavicle. A pad of fibro- cartilage is present in between bones.

Acromio clavicular joint - joints between clavicle and acromion process of scapula. A pad of cartilage is present. Only limited movement is possible.

Shoulder joint - It is a ball and socket type of synovial joint. The head of humerus with glenoid cavity of scapula forms it. Ligaments connect bones. Synovial cavity lies between the joint. It allows movements in all directions.

Elbow joint - it is a hinge joint. Here three bones participate. Lower end of humerus above and the upper ends of radius and ulna below forming humero ulnar & humero radial joints.

Radio Ulnar joints - joints between these two bones.

Superior radio ulnar joints - are between head of radius with radial notch of ulna.

Middle radio ulnar joint - between the shafts of radius and ulna, which allows a special movement, known as pronation and supination.

Inferior radio ulnar joint - between the lower ends of radius and ulna

Wrist joint - Between lower end of radius and ulna above and the proximal row of carpal bones below. Flexion, extension, and adduction, abduction movements take place at this joint.

Carpometacarpal joints - are between carpal and metacarpal bones. Flexion and extension movements take place at these joints.

Metacarpo phalangeal joints - Between metacarpal and phalanges. This joint allows flexion, extension, abduction & adduction.

Interphalangeal joints - Between phalangeal bones. Flexion and extension movements occur at these joints.

Joints of lower limb:

Hip joint - it is a ball & socket type. It is formed by acetabulum of hipbone and head of femur. Strong ligaments strengthen the joint. It allows movements in all directions.

Knee joint - it is a modified hinge type. Lower end of femur articulates with upper end of tibia and patella. Flexion and extension takes place in this joint. In the final stage of extension there is also a locking mechanism, which helps us to stand steadily.

Ankle joint - it is also a hinge type. Lower end of tibia, lower end of fibula and talus take part in the formation of the joint. Possible movements are dorsiflexion and plantar flexion.

Subtalar and Midtarsal joints - Joints between the tarsal bones.

Inversion and eversion movements take place at subtalar and midtarsal joints.

Tarso metatarsal joints – are between tarsal and metatarsal bones.

Metatarso-phalangeal joints – are between metatarsal and phalangeal bones.
Flexion extension movements take place at these joints

Interphalangeal joints – are between the phalanges of digits – flexion and extension take place at these joints.

QUESTIONS

1. Draw a schematic diagram of synovial joint and label the parts.
2. Name the classification of synovial joints.



4. MUSCLES

Study of muscles is known as **myology**. Muscles are mainly for producing various movements of different parts of body. Based on their appearance under the microscope, they are classified as follows:

Smooth muscle fibers when seen under microscope do not show striations. They are also not under our control and therefore smooth muscles are also called **involuntary muscles**. They are mainly present in organs of the body, e.g. oesophagus, stomach etc.,

Striated muscle fibers under the microscope reveal striations. They are also called skeletal muscles because they are mainly attached to the bones of skeleton. Since they are under our control they are called **voluntary muscles**. e.g. biceps brachial, deltoid etc.,

Cardiac muscle fibers also show striations when viewed under microscope but they are not under our control. They are present in heart.

Skeletal muscles:

There are more than 600 muscles present in the body and account for 40% to 50% of the body weight and also give shape to the body. Since they always cross-joints their contraction produces movements at those joints of the body.

Muscles are named in different ways.

According to their shape eg. Deltoid, trapezius

According to their position eg. Pectoralis major

According to their attachment eg. Sternocleidomastoid

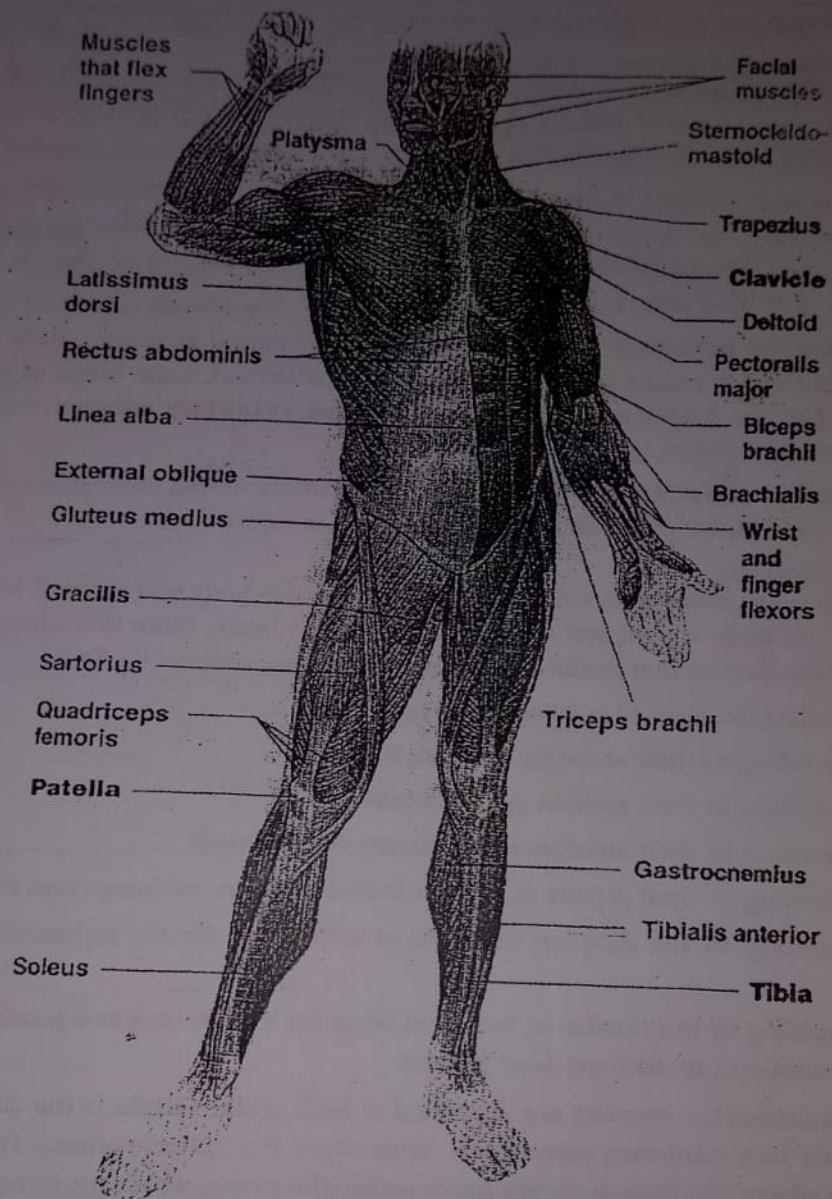
According to their actions eg. Flexor hallucis longus, extensor carpi radialis

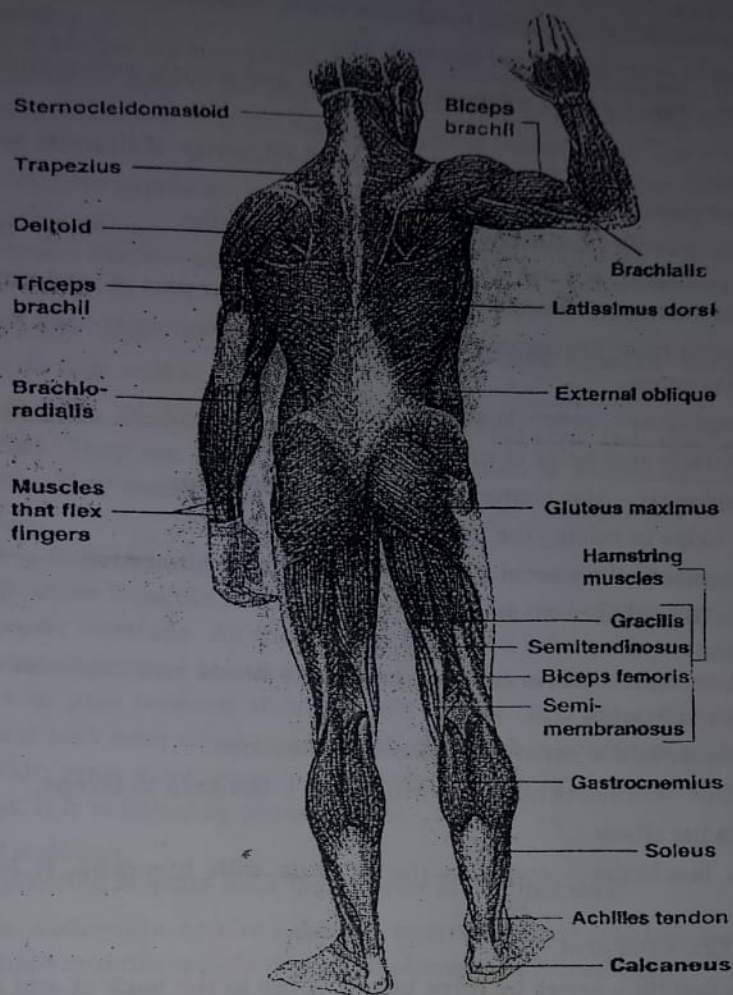
According to the direction of fibres of muscle eg. Rectus abdominis, obliquus capitis

According to the number of heads of origin such as biceps (two heads), Triceps (three heads) and quadriceps (four heads).

Attachment – muscles are attached at both ends. **Origin** is the place where the muscle has minimum movement (from where the muscle arises). **Insertion** is the place where the muscle shows more action (the place, where the muscle ends).

If the connecting part of muscle to bone is rounded, white, glistening, inelastic fibrous then it is known as **tendon**. If the connecting part of muscle to bone is flattened fibrous sheet – like then it is called **aponeurosis**.





MUSCLES OF HEAD AND NECK:

Muscles of head and neck can be grouped as follows:

Muscles of scalp – scalp is the soft part, which covers the head and it, contains the occipito frontal is muscle.

Muscles of facial expression – muscles are helping to express our feelings without verbal communication. These muscles are supplied by facial nerve.

Orbicularis oculi – is surrounding eye.

Orbicularis oris - is surrounding mouth.

Buccinator - forming the cheek.

Muscles of mastication:

These muscles help in chewing and are called masticatory muscles. They are temporalis, masseter, medial and lateral pterygoids. (Jaw closures) mylohyoid and anterior belly of digastric (Jaw openers) muscles are supplied by mandibular nerve.

Muscles of neck:

These muscles connect the head with trunk. Important muscles are

Platysma - connects lower jaw with chest.

Sterno cleido mastoid - connects sternum and clavicle with mastoid process of skull.

Trapezius - connects occipital bone and all spines of thoracic vertebrae with scapula and clavicle.

Scalene muscle - connects cervical vertebrae to ribs.

Muscles of shoulder:

Deltoid - connects clavicle and scapula with upper part of humerus.

It helps to raise the upper limb. This muscle is commonly used for giving intra muscular injections.

Supraspinatus - connects scapula with humerus.

This muscle also helps to raise the upper limb.

Infra spinatus - also connects scapula with humerus.

It also helps in raising the upper limb.

Subscapularis - connects again the scapula with humerus.

It helps in medial rotation of upper limb.

Muscles of arm:

Biceps brachii - this muscle arises by two heads and connects scapula with radius. It lies in front of arm.

It is a flexor and a powerful supinator of fore arm.

Brachialis - connects humerus with ulna. It lies deep to biceps.

It flexes the elbow.

Coraco brachialis - connects the scapula with humerus. It lies medial to biceps.

It also flexes the arm.

Triceps brachii - arises by three heads. It lies in the back of arm and connects humerus to ulna. It is an extensor of the elbow.

Forearm muscles:

Group of muscles in front of forearm produces flexion of wrist, hand and fingers (flexors) Group of muscles at the back of forearm produces extension of wrist, hand and fingers (extensors).

Flexor group:

Pronator teres, flexor carpi ulnaris, flexor carpi radialis, flexor digitorum superficialis, flexor digitorum profundus pronator quadratus and flexor pollicis longus form this group.

Extensor group:

It comprises supinator, anconeus, extensor digitorum, extensor carpi radialis longus, extensor carpi radialis brevis, extensor carpi ulnaris, brachio radialis and abductor pollicis longus.

Hand muscles:

There are two eminences thenar and hypothenar eminences. Thenar eminence is situated at the base of the thumb. It is made up of four small muscles. Similarly, hypothenar eminence is at the base of the little finger. Small worm like muscles are known as lumbricals. In relationship to the long flexor tendons and small muscles in between metacarpals are known as interosseous muscles.

Muscles of thorax:

Pectoralis major – this muscle is present in front of the chest and connects rib cage with humerus,

Pectoralis minor – this small muscle present beneath the above muscle connects rib cage with scapula.

Intercostals muscles – are the muscles between the ribs and has three components. They are external intercostals, internal intercostals and innermost intercostals. They connect the adjacent ribs.

Diaphragm:

It is a large dome like muscular partition between thoracic and abdominal cavities. It arises from the inner aspect of the lower part of sternum, lower ribs and lower thoracic vertebrae. All the muscle fibres are inserted into central portion as an aponeurosis (central tendon). Since it acts as a partition, it has openings for structures to pass between abdomen and thorax. The major openings are aortic, oesophageal and vena caval openings through these openings aorta, oesophagus and inferior vena cava pass respectively. This is an important muscle for respiration. It is supplied by phrenic nerve.

Muscles of abdomen:

The following muscles form the anterior abdominal wall:

Rectus abdominis, external oblique, internal oblique and transverse abdominis muscle. These muscles mainly connect hipbone with thoracic cage.

On the back **quadratus lumborum**, **iliacus** and **psoas** muscles form the posterior abdominal wall. **Quadratus lumborum** connects the last rib with hipbone. **Iliacus** connects the hip bone with femur and **psoas** connects lumbar vertebrae with femur.

Superficial muscles of back:

Latissimus dorsi – connects vertebral column and hipbone with humerus.

Levator scapulae – connects cervical vertebrae with scapula.

Rhomboideus - there are two rhomboideus. They connect cervical and thoracic vertebrae with scapula.

Muscles of pelvis:

Levator ani and **coccygeus** are main muscles of pelvic floor.

Muscles of gluteal region:

In the gluteal (buttock) region following muscles are present.

They are gluteus maximus, gluteus medius, gluteus minimus and piriformis. Piriformis is the key muscle of this region because important nerves and blood vessels are closely related to this small muscle.

Gluteus medius is generally chosen for intra muscular injections. (Upper and outer quadrant of gluteal region)

Muscles of thigh:

Muscles are arranged in three groups.

They are **extensors** of knee in front of thigh, **flexors** of knee at the back of thigh and **adductors** of hip on the medial side of thigh.

Muscles in front of thigh - The bulky muscle seen in front of thigh is called quadriceps femoris and is formed by the union of four muscles viz., rectus femoris, vastus medialis, vastus intermedius and vastus lateralis. The tendon of quadriceps femoris muscle is called ligamentum patellae and is inserted into the upper end of tibia. Patella the kneecap is present in this tendon.

Muscles in the medial aspect of thigh - are gracilis, adductor longus, adductor magnus and adductor brevis. They produce adduction of hip joint.

Muscles of back of thigh - are semimembranous, semitendinosus and biceps femoris. Collectively, these muscles are called hamstring muscles. These muscles produce flexion of the knee joint.

Muscles of leg:

Leg muscles can be divided into 3 groups. They are anterior, posterior and lateral (peroneal).

Anterior group muscles are tibialis anterior and extensor digitorum longus and they produce dorsiflexion of foot at the ankle joint and inversion at the subtalar and mid tarsal joints.

Posterior group muscles are gastrocnemius, soleus, tibialis posterior and flexor digitorum longus and they produce plantar flexion of foot.

Lateral group muscles are peroneus longus and peroneus brevis and they produce eversion of foot.

Sole of Foot - there are small muscles for the big toe and small toe separately as seen in the hand. Besides other small muscles are between the bones of foot.

QUESTIONS:

1. Name the chewing muscles and their nerve supply.
2. Name the muscles of face and their nerve supply?
3. Describe the diaphragm, its action and nerve supply.
4. Name the muscles that bring about supination and pronation of fore arm.
5. Name the muscles, which bring about inversion and eversion of foot.