Introduction To Human Anatomy
Lecture Two

Objectives

AN1.1	1-Demonstrate normal anatomical position, various planes, relation, comparison, laterality in our body
AN1.2	2-Describe the variuos types of movements in our body
AN2.1	**3-Describe composition of bone and bone marrow**
AN2.2	**4-Describe the classification system of bones**
AN2.3	**5-Describe parts, blood and nerve supply of a long bone**
AN2.4	**6-Enumerate special features of a sesamoid bone**
AN2.5	**7-Enumerate types of ossification**
AN2.6	**8-Demonstrate different types of bone markings and explain their formation**
AN3.1	9-Describe various types of cartilage with its structure & distribution in body
AN3.2	10-Describe various joints with subtypes and examples
AN3.3	11-Explain the concept of nerve supply of joints & Hilton's law

Bones

Bone is a specialised type of connective tissue. It has a unique histological appearance, which enables it to carry out its numerous functions:

1-Haematopoiesis – the formation of blood cells from haematopoietic stem cells found in the bone marrow.

2-Lipid and mineral storage – bone is a reservoir holding adipose tissue within the bone marrow and calcium within the hydroxyapatite crystals.

3-Support – bones form the framework and shape of the body.

4-Protection – especially the axial skeleton which surrounds the major organs of the body.

In this article, we shall look at the ultrastructure of bone – its components, structure and development. We shall also examine how disease can affect its structure.

Components of Bone

Bone is a specialised form of connective tissue. Like any connective tissue, its components can be divided into cellular components and the extracellular matrix.

Cellular Components

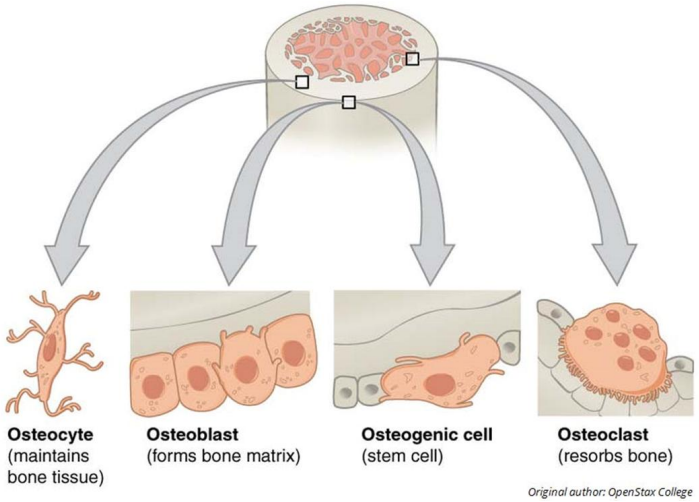
There are three types of cells in bone:

1-**Osteoblasts** – Synthesise uncalcified/unmineralised extracellular matrix called osteoid. This will later become calcified/mineralised to form bone.

2-Osteocytes – As the osteoid mineralises, they mature into osteocytes. They then monitor the minerals and proteins to regulate bone mass.

3-Osteoclasts – resorb bone. They are large and multinucleated cells.

The balance of osteoblast to osteoclast activity is crucial in the maintenance of the tissue's structural integrity.



Extracellular Matrix

The extracellular matrix (ECM) refers to the molecules that provide biochemical and structural support to the cells.

The ECM of bone is highly specialized. In addition to collagen and the associated proteins usually found in connective tissue, bone is impregnated with mineral salts, in particular calcium hydroxyapatite crystals. These crystals associate with the collagen fibres, making bone hard and strong. This matrix is organised into numerous thin layers, known as lamellae.

Structure of Bone

Under the microscope, bone can be divided into two types:

1-Woven bone (primary bone) – Appears in embryonic development and fracture repair, as it can be laid down rapidly. It consists of osteoid (unmineralised ECM), with the collagen fibres arranged randomly. It is a temporary structure, soon replaced by mature lamellar bone.

2-Lamellar bone (secondary bone) – The bone of the adult skeleton. It consists of highly organised sheets of mineralised osteoid. This organised structure makes it much stronger than woven bone. Lamella bone itself can be divided into two types – ***compact and spongy.***

In both types of bone, the external surface is covered by a layer of connective tissue, **known as the periosteum**.

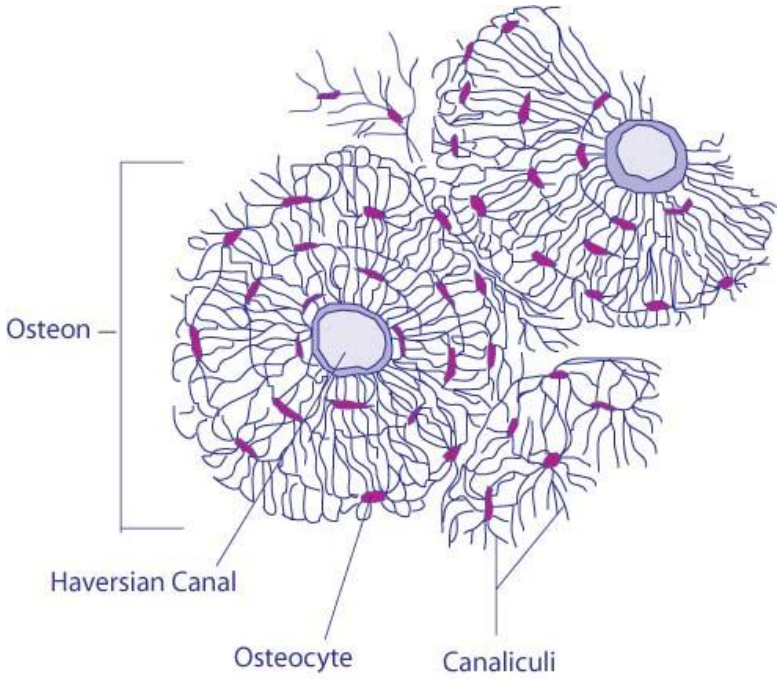
Lamellar bone can be divided into two types. The outer is known as compact bone – this is dense and rigid. The inner layers of bone are marked by many interconnecting cavities and is called spongy bone.

Compact Bone

Compact bone forms the outer 'shell' of bone. In this type of bone, the lamellae are organised into concentric circles, which surround a vertical Haversian canal (which transmits small neurovascular and lymphatic vessels). This entire structure is called an osteon and is the functional unit of bone.

The Haversian canals are connected by horizontal Volkmann's canals – these contain small vessels that anastomose (join) with the arteries of the Haversian canals. The Volkmann's canals also transmit blood vessels from the periosteum.

Osteocytes are located between the lamellae, within small cavities (known as lacunae). The lacunae are interconnected by a series of interconnecting tunnels, called canaliculi.



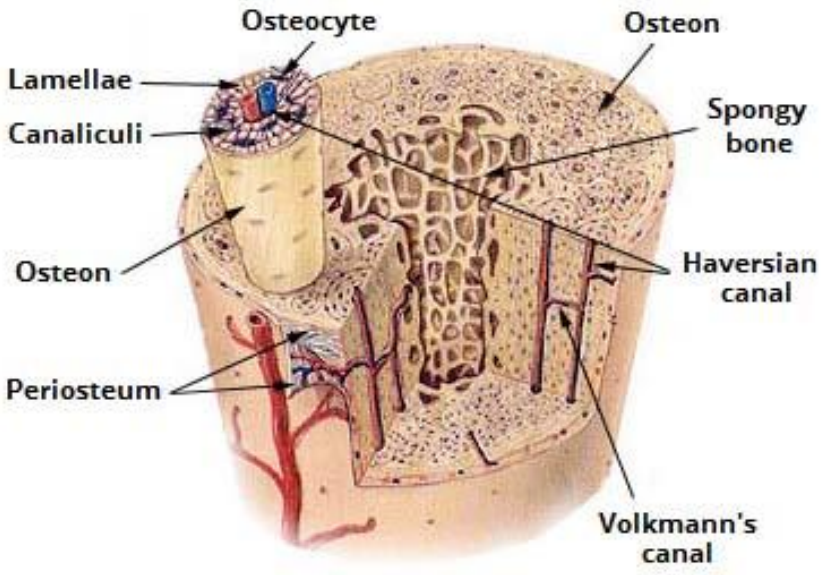
Spongy Bone

Spongy bone makes up the interior of most bones and is located deep to the compact bone. It contains many large spaces – this gives it a honeycombed appearance.

The bony matrix consists of a 3D network of fine columns, which crosslink to form irregular trabeculae. This produces a light, porous bone, that is strong against multidirectional lines of force. The lightness afforded to spongy bone is crucial in allowing the body to move. If the only type of bone was compact, they would be too heavy to mobilise.

The spaces between trabeculae are often filled with bone marrow. Yellow bone marrow contains adipocytes and red bone marrow consists of haematopoietic stem cells.

This type of bone does not contain any Volkmann's or Haversian canals.



Ossification and Remodelling

Ossification is the process of producing new bone. It occurs via one of two mechanisms:

Endochondral ossification – Where hyaline cartilage is replaced by osteoblasts secreting osteoid. The femur is an example of a bone that undergoes endochondral ossification.

Intramembranous ossification – Where mesenchymal (embryonic) tissue is condensed into bone. This type of ossification forms flat bones such as the temporal bone and the scapula.

In both mechanisms, primary bone is initially produced. It is later replaced by mature secondary bone.

Remodelling

Bone is a living tissue and as such constantly undergoes remodelling. This is the process whereby mature bone tissue is reabsorbed, and new bone tissue is formed. It is carried out by the cellular component of bone.

Osteoclasts break down bone , the nutrients are reabsorbed, and osteoblasts lay down new osteoid. Remodelling occurs primarily at sites of stress and damage, strengthening the areas affected.

Clinical Relevance - Disorders of Bone

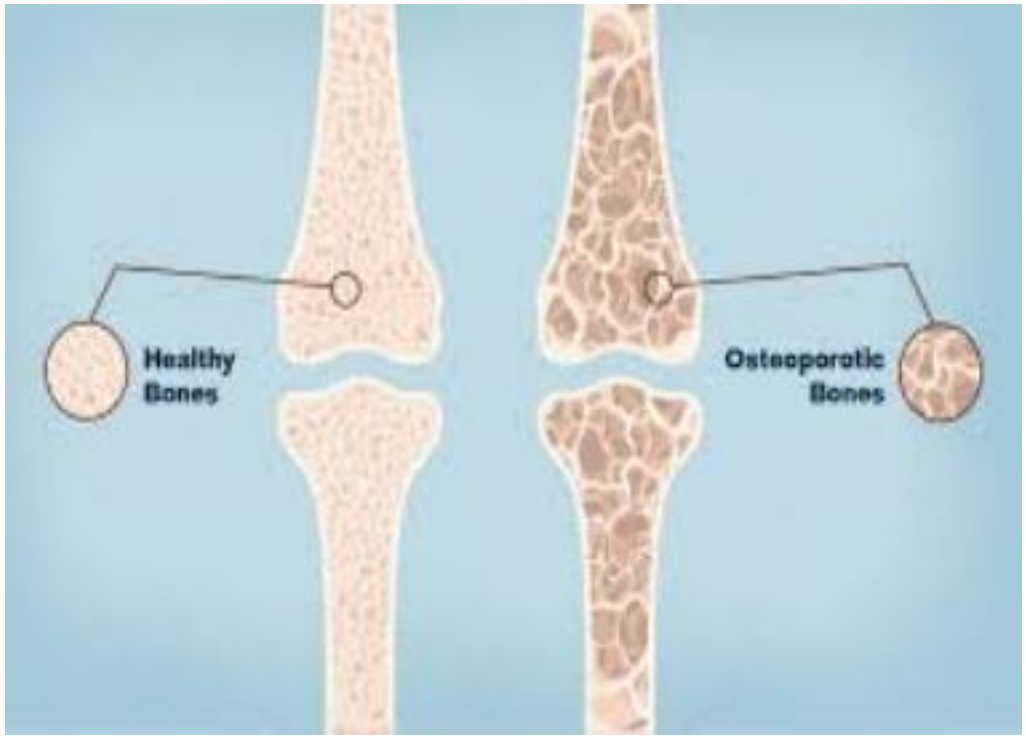
Bone has a unique histological structure, which is required for it to carry out its functions. Alterations to this structure, secondary to disease, can give rise to several clinical conditions.

Osteogenesis imperfecta is a condition in which there is abnormal bone synthesis . Clinical features include fragile bones, bone deformities . The fragility of the bones predisposes them to fracture .

Osteoporosis refers to a decrease in bone density, reducing its structural integrity. This is produced by osteoclast activity . The bones are fragile, and at an increased risk of frcture.

Risk factors include age, gender, diet (vitamin D and calcium), ethnicity, smoking and immobility.

osteogenic imperficta



osteoprosis

Classification of Bones

Bones are classified according to their shape.

1-Long bones are tubular (e.g., the humerus in the arm).

2-Short bones are cuboidal and are found only in the ankle (tarsus) and wrist (carpus).

3-Flat bones usually serve protective functions (e.g., those forming the cranium protect the brain).

4-Irregular bones (e.g., in the face) have various shapes other than long, short, or flat.

5-Sesamoid bones (e.g., the patella or knee cap) develop in certain tendons and are found where tendons cross the ends of long bones in the limbs.

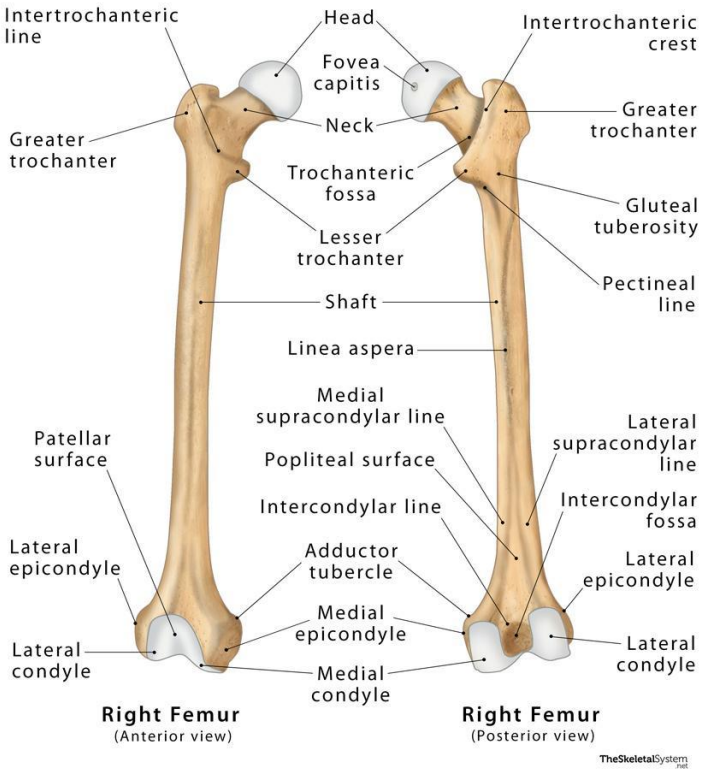
Bone Markings and Formations

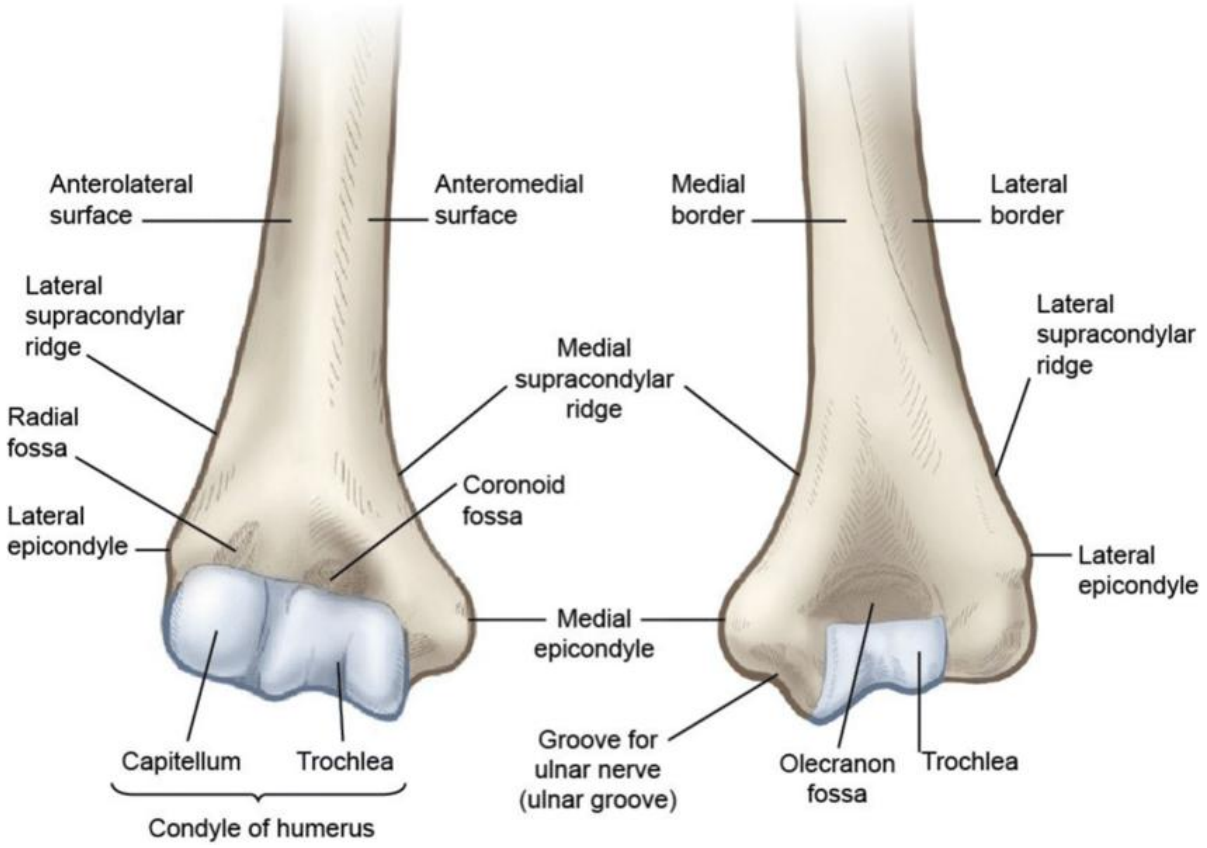
Bone markings appear wherever tendons, ligaments, and fascias are attached or where arteries lie adjacent to or enter bones.

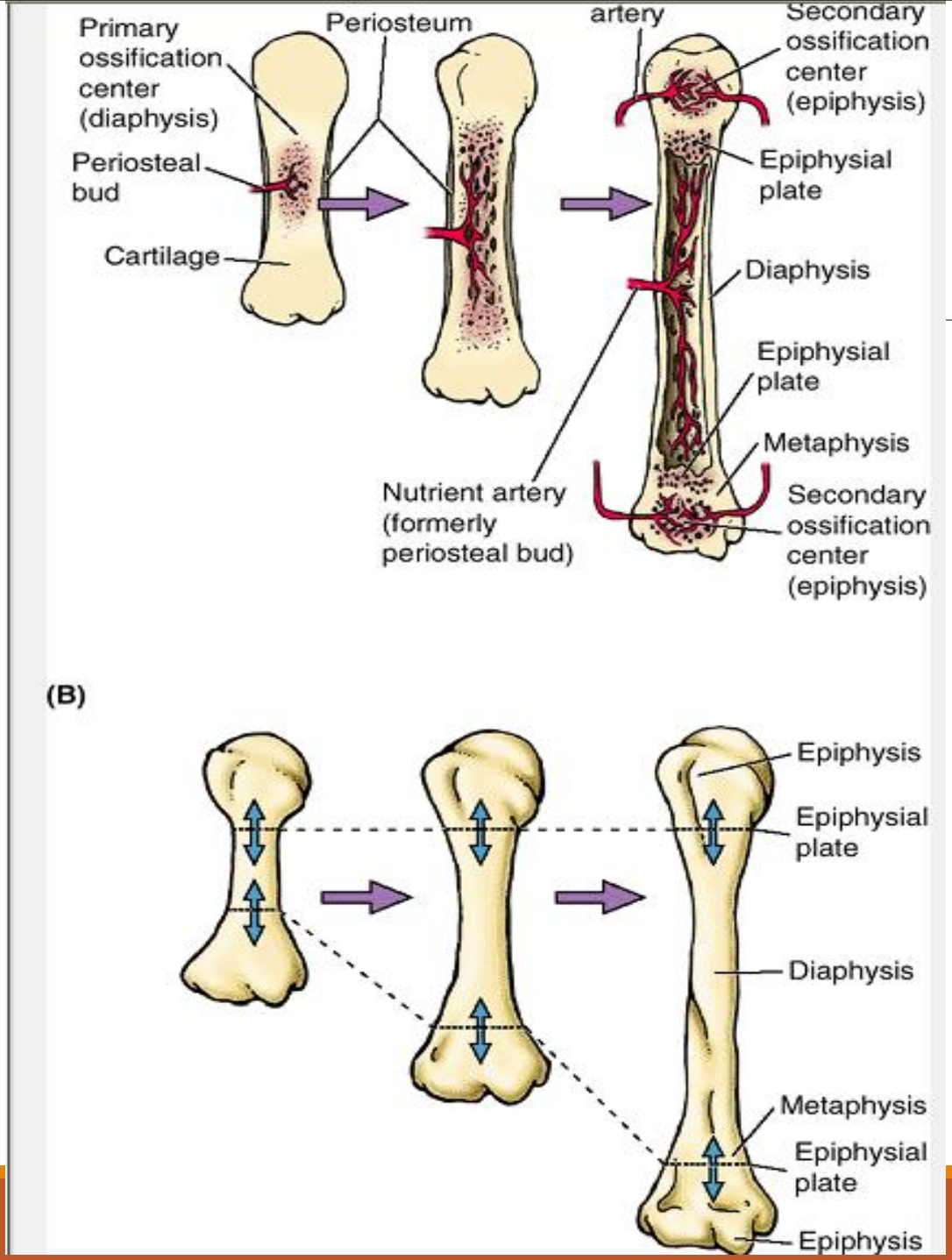
Capitulum: small, round, articular head (e.g., the capitulum of the humerus).

- **Condyle:** rounded, knuckle-like articular area, usually occurring in pairs (e.g., the lateral femoral condyle).
- **Crest:** ridge of bone (e.g., the iliac crest).
- **Epicondyle:** eminence superior to a condyle (e.g., the lateral epicondyle of the humerus).
- **Facet:** smooth flat area, usually covered with cartilage, where a bone articulates with another bone (e.g., the superior costal facet on the body of a vertebra for articulation with a rib).
- **Foramen:** passage through a bone (e.g., the obturator foramen).
- **Fossa:** hollow or depressed area (e.g., the infraspinous fossa of the scapula).
- **Groove:** elongated depression or furrow (e.g., the radial groove of the humerus).
- **Head** (L. caput): large, round articular end (e.g., the head of the humerus).

Femur


Intertrochanteric line
Head
Fovea capitis
Neck
Greater trochanter
Trochanteric fossa
Lesser trochanter
Shaft
Linea aspera
Medial supracondylar line
Popliteal surface
Intercondylar line
Adductor tubercle
Medial epicondyle
Medial condyle
Patellar surface
Lateral epicondyle
Lateral condyle
Right Femur
(Anterior view)
Intertrochanteric crest
Greater trochanter
Gluteal tuberosity
Pectineal line
Lateral supracondylar line
Intercondylar fossa
Lateral epicondyle
Lateral condyle
Right Femur
(Posterior view)
TheSkeletalSystem.net

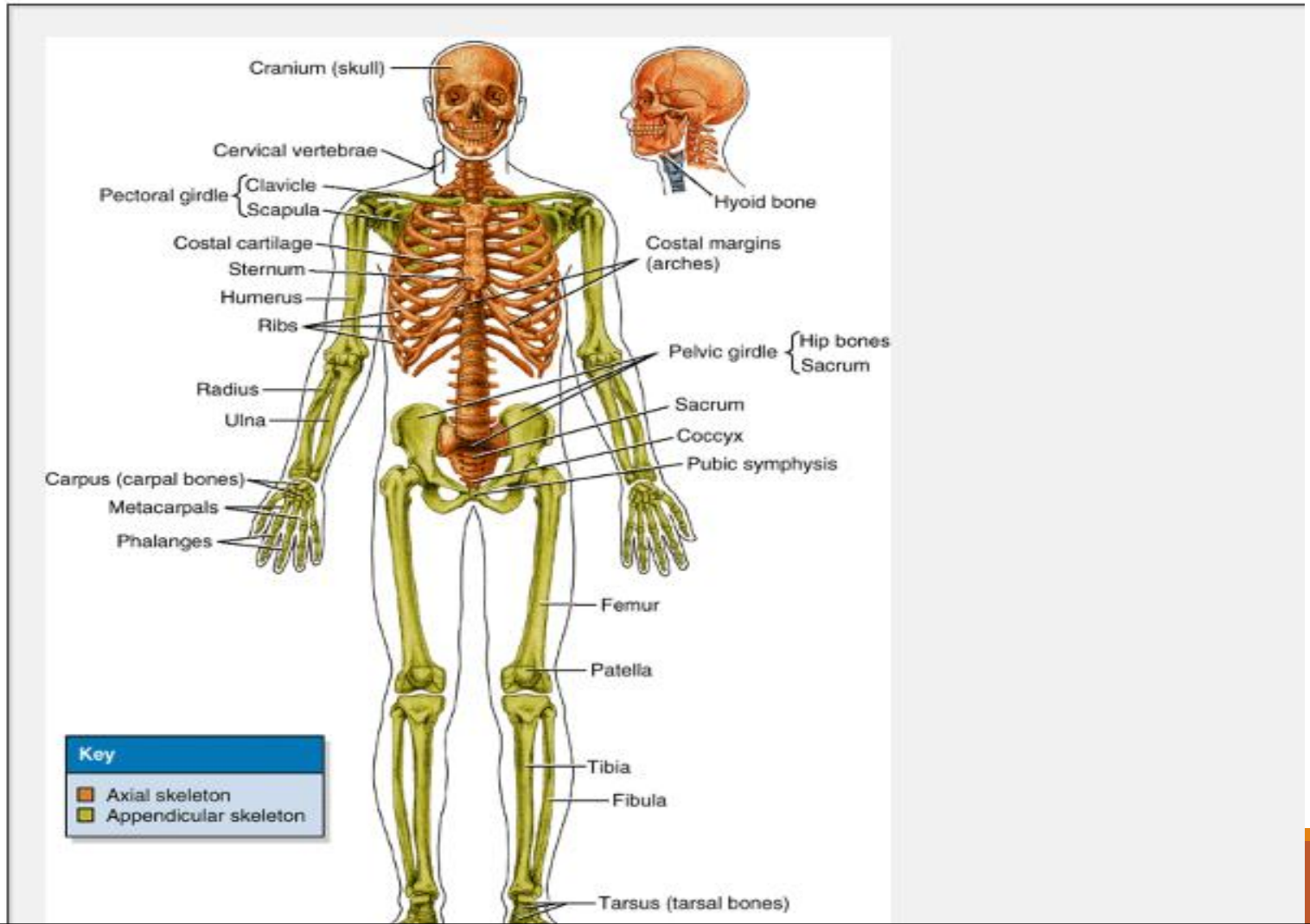

Anterolateral surface
Anteromedial surface
Lateral supracondylar ridge
Radial fossa
Lateral epicondyle
Medial supracondylar ridge
Coronoid fossa
Medial epicondyle
Capitellum
Trochlea
Condyle of humerus
Medial border
Lateral border
Lateral supracondylar ridge
Lateral epicondyle
Groove for ulnar nerve (ulnar groove)
Olecranon fossa
Trochlea


Primary ossification center (diaphysis)
Periosteum
artery
Secondary ossification center (epiphysis)
Periosteal bud
Epiphysial plate
Cartilage
Diaphysis
Epiphysial plate
Metaphysis
Nutrient artery (formerly periosteal bud)
Secondary ossification center (epiphysis)
(B)
Epiphysis
Epiphysial plate
Diaphysis
Metaphysis
Epiphysial plate
Epiphysis

Skeletal System

The skeletal system may be divided into two functional parts (Fig. I.11):

- The **axial skeleton** consists of the bones of the head (*cranium* or *skull*), neck (*vertebrae*), and trunk (*ribs*, *sternum*, *vertebrae*, and *sacrum*).



Bone development:

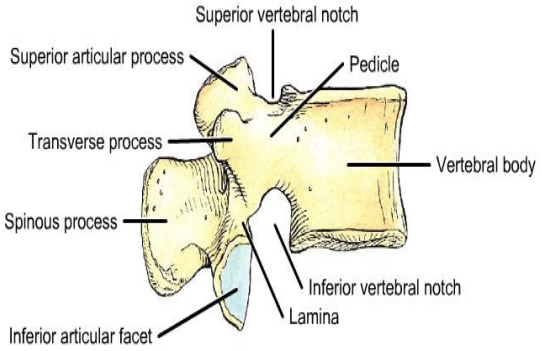
By two process:-

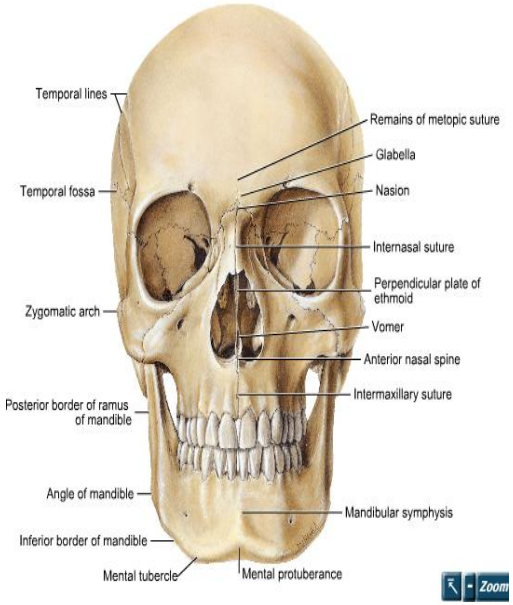
1- membranous development from connective tissue membrane .(in skull)

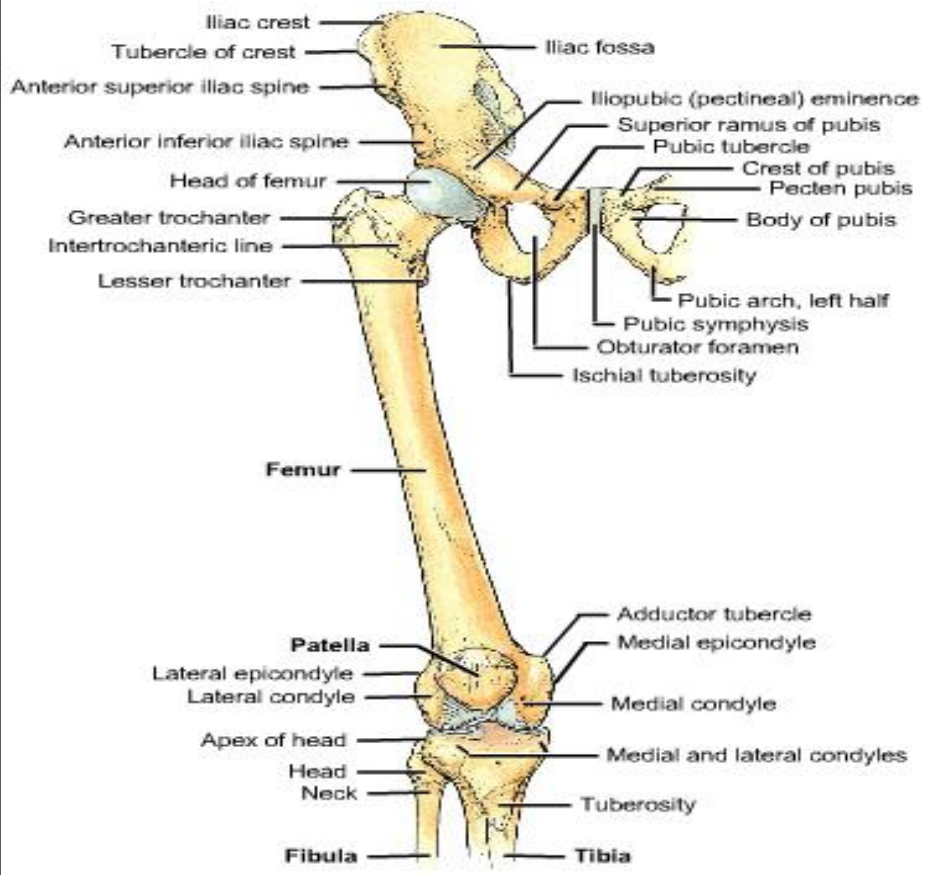
2- endochondral development cartilaginous model (in long bones)

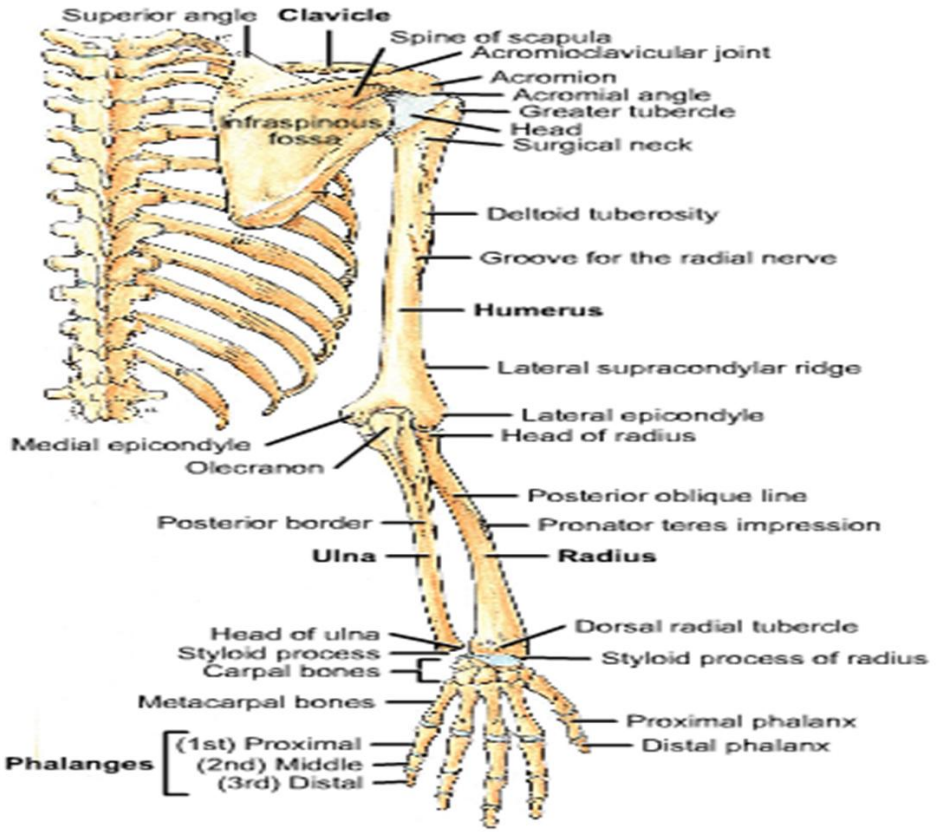
Humerus and Scapula

Anterior View - Features






Iliac crest
Tubercle of crest
Anterior superior iliac spine
Anterior inferior iliac spine
Head of femur
Greater trochanter
Intertrochanteric line
Lesser trochanter
Iliac fossa
Iliopubic (pectineal) eminence
Superior ramus of pubis
Pubic tubercle
Crest of pubis
Pecten pubis
Body of pubis
Pubic arch, left half
Pubic symphysis
Obturator foramen
Ischial tuberosity
Femur
Patella
Lateral epicondyle
Lateral condyle
Apex of head
Head
Neck
Fibula
Adductor tubercle
Medial epicondyle
Medial condyle
Medial and lateral condyles
Tuberosity
Tibia


Superior angle
Clavicle
Spine of scapula
Acromioclavicular joint
Acromion
Acromial angle
Greater tubercle
Head
Surgical neck
Infraspinous fossa
Deltoid tuberosity
Groove for the radial nerve
Humerus
Lateral supracondylar ridge
Lateral epicondyle
Head of radius
Medial epicondyle
Olecranon
Posterior oblique line
Posterior border
Pronator teres impression
Ulna
Radius
Head of ulna
Styloid process
Carpal bones
Dorsal radial tubercle
Styloid process of radius
Metacarpal bones
Proximal phalanx
Distal phalanx
Phalanges
(1st) Proximal
(2nd) Middle
(3rd) Distal

BLOOD VESSELS

Are three types : **Artery**

Vein

Capillary

Artery:

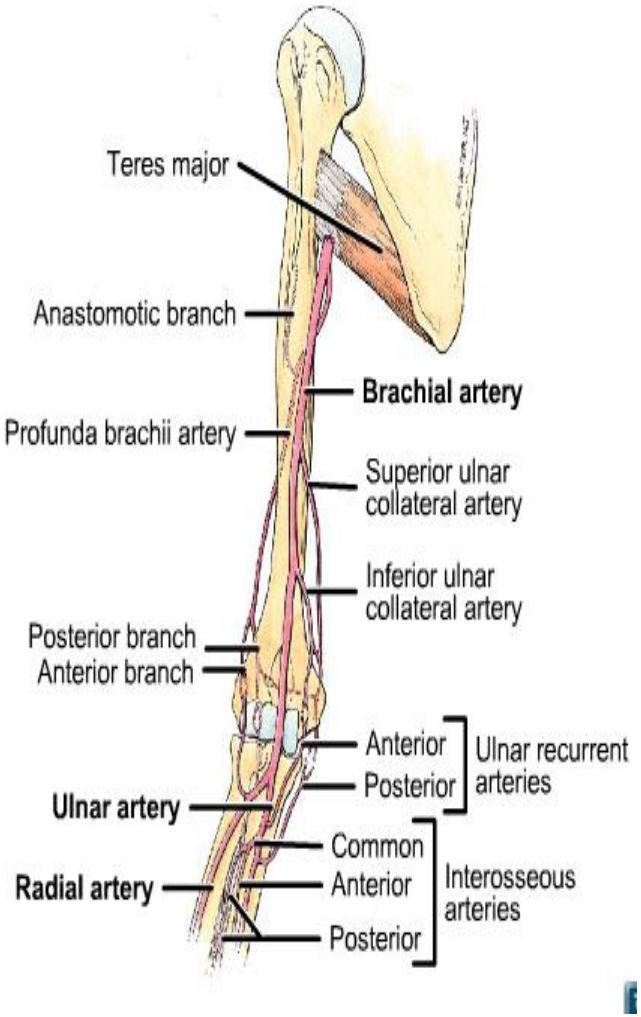
They have branches which supply to various tissue of body.

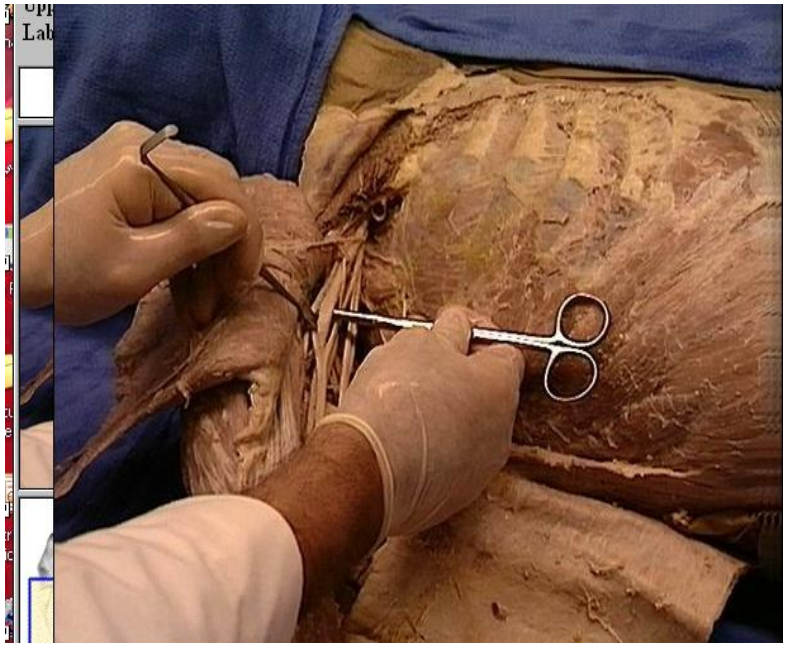
- different types of artery depend on thickness of wall so we have:-

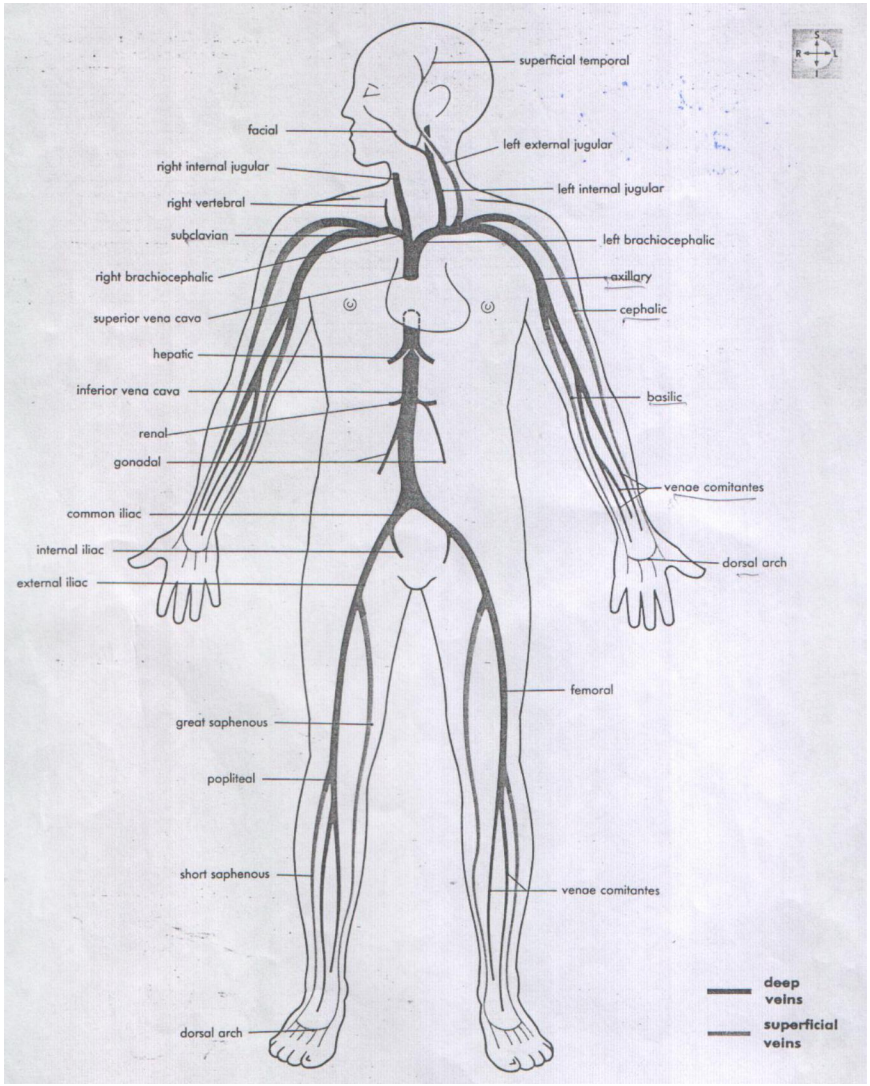
1- smallest artery less than 0.1 mm in diameter called arterioles.

2- large artery – Aorta (2.5 cm) in diameter.

- Joining of branches of arteries called *anastomosis*.

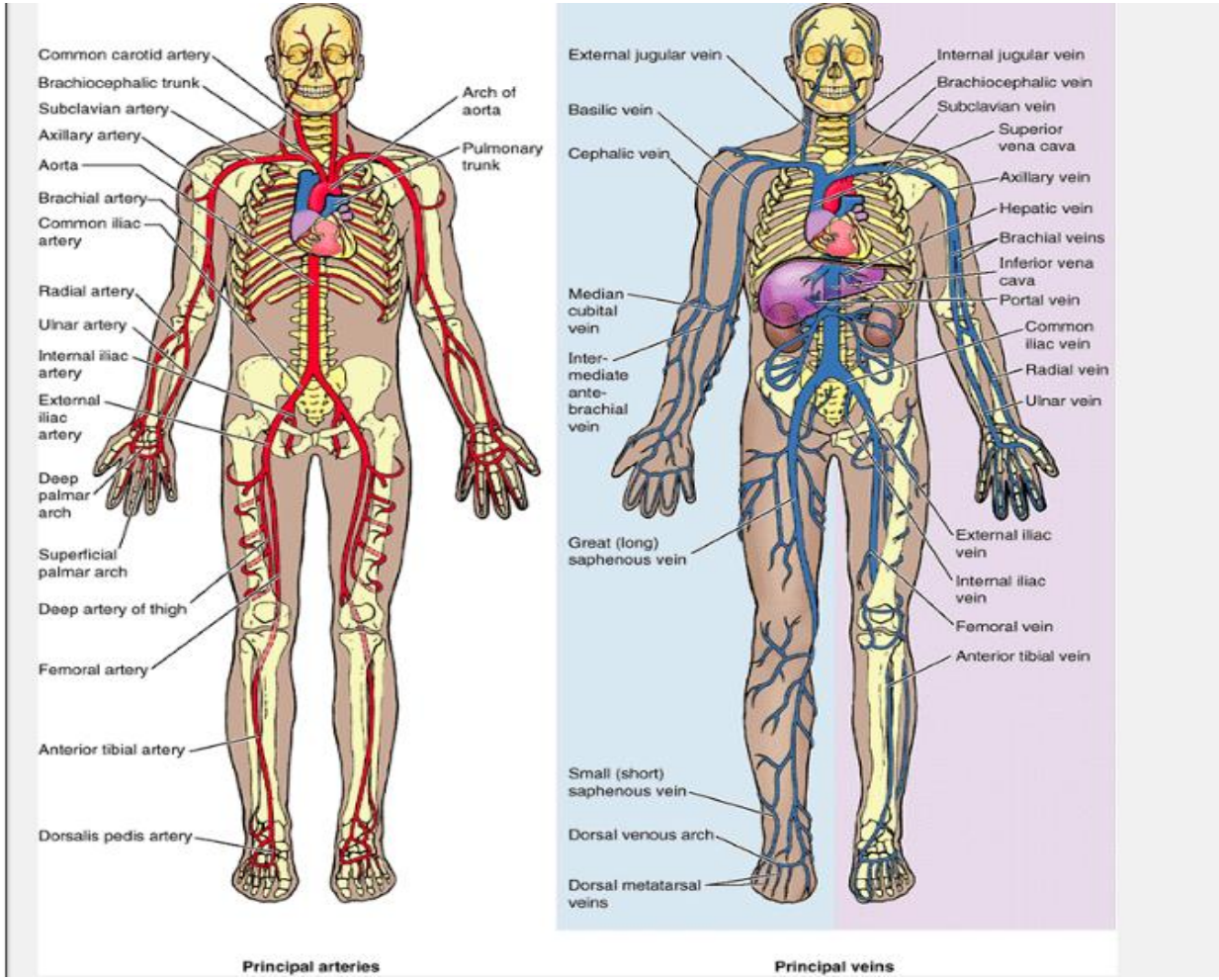

Teres major
Anastomotic branch
Brachial artery
Profunda brachii artery
Superior ulnar collateral artery
Inferior ulnar collateral artery
Posterior branch
Anterior branch
Anterior
Posterior
Ulnar recurrent arteries
Ulnar artery
Common
Anterior
Posterior
Interosseous arteries
Radial artery

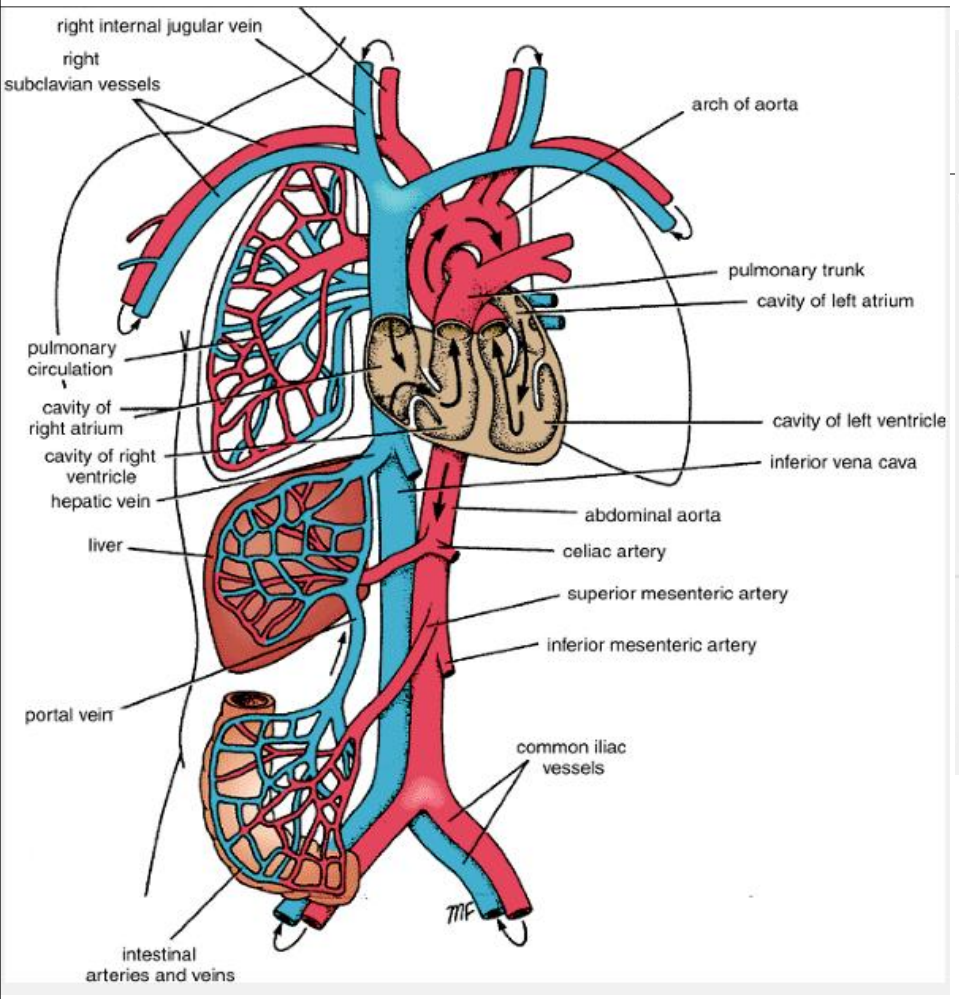



superficial temporal
facial
left external jugular
right internal jugular
left internal jugular
right vertebral
subclavian
left brachiocephalic
right brachiocephalic
axillary
superior vena cava
cephalic
hepatic
inferior vena cava
basilic
renal
gonadal
venae comitantes
common iliac
internal iliac
dorsal arch
external iliac
femoral
great saphenous
popliteal
short saphenous
venae comitantes
dorsal arch
deep veins
superficial veins

Anatomic end artery **:-** are vessels whose terminal branches do not anastomosis with antaries supply adjacent area (found in eye, brain, lung, kidney, spleen)

Functional end artery **:-** There is anastomosis with adjacent arteries, but this anastomosis is insufficient to keep the tissue alive (found in heart).


Common carotid artery
Brachiocephalic trunk
Subclavian artery
Axillary artery
Aorta
Brachial artery
Common iliac artery
Radial artery
Ulnar artery
Internal iliac artery
External iliac artery
Deep palmar arch
Superficial palmar arch
Deep artery of thigh
Femoral artery
Anterior tibial artery
Dorsalis pedis artery
Arch of aorta
Pulmonary trunk
Principal arteries
External jugular vein
Basilic vein
Cephalic vein
Median cubital vein
Inter-mediate ante-brachial vein
Great (long) saphenous vein
Small (short) saphenous vein
Dorsal venous arch
Dorsal metatarsal veins
Internal jugular vein
Brachiocephalic vein
Subclavian vein
Superior vena cava
Axillary vein
Hepatic vein
Brachial veins
Inferior vena cava
Portal vein
Common iliac vein
Radial vein
Ulnar vein
External iliac vein
Internal iliac vein
Femoral vein
Anterior tibial vein
Principal veins



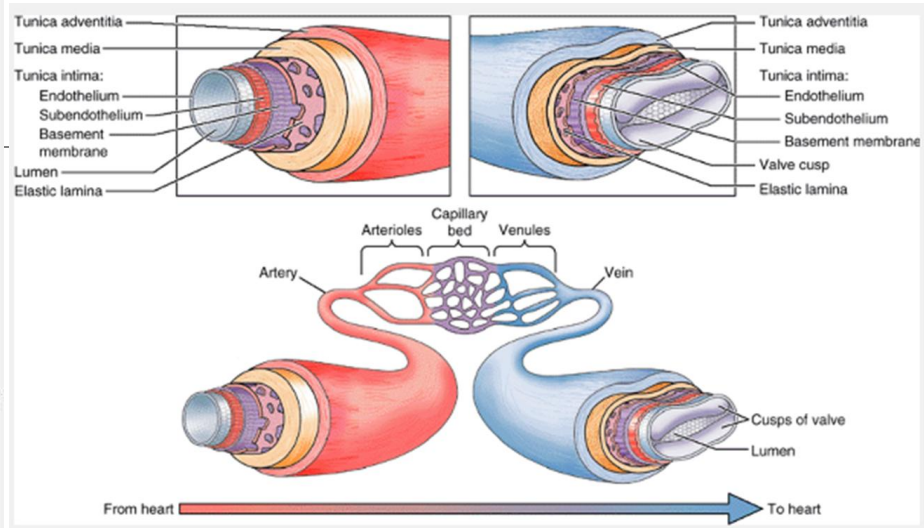
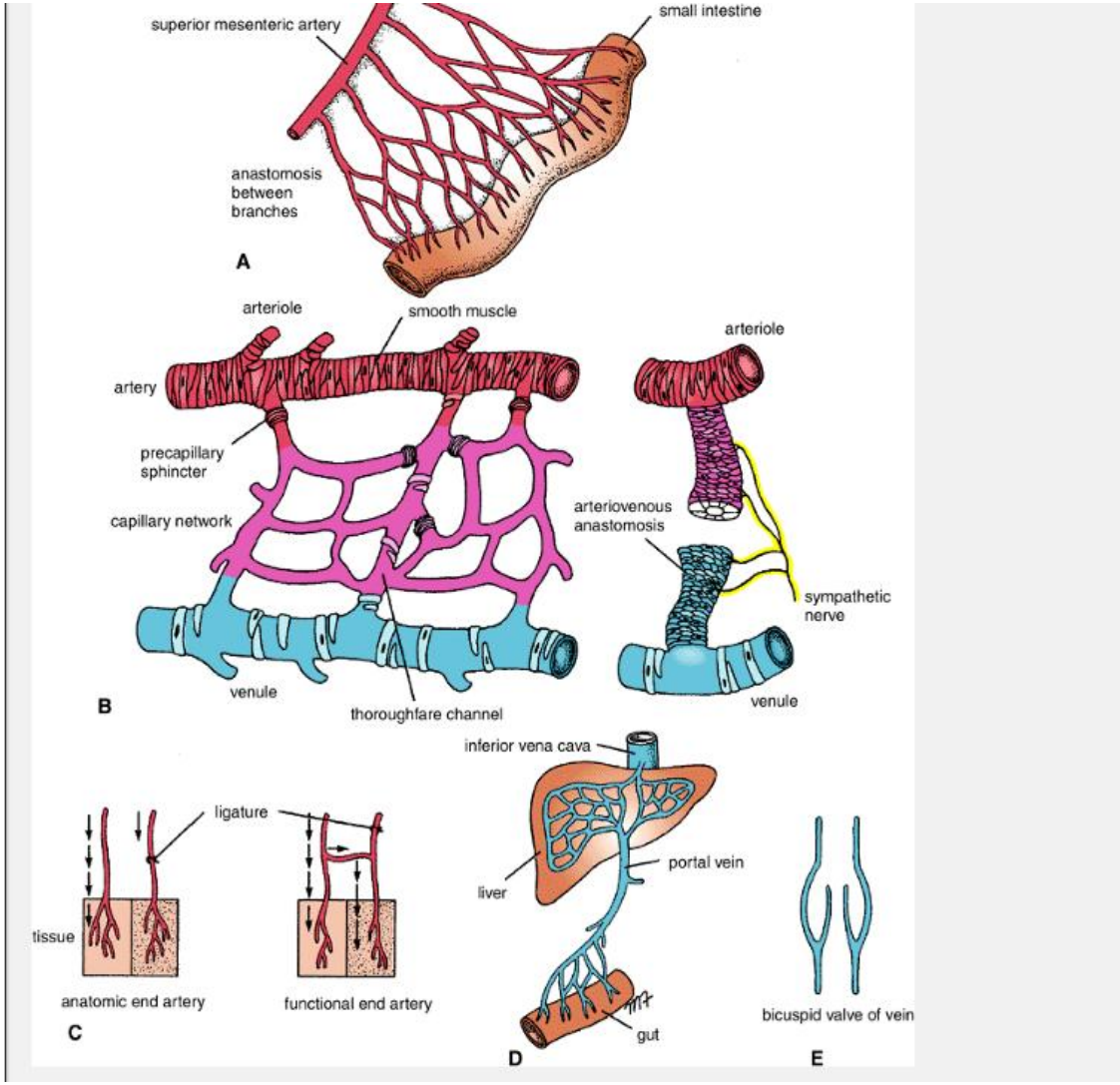


Figure I.23. Blood vessel structure. The walls of most blood vessels have three tissue, called tunics (L. *tunicae*, coats). With less muscle, veins are thinner walled arteries and have wide lumens (L. *luminae*) that usually appear flattened in tissue veins that return blood to the heart against gravity (e.g., leg veins) have valves t columns of blood and, if healthy, allow blood to flow only toward the heart.


superior mesenteric artery
small intestine
anastomosis between branches
A
arteriole
smooth muscle
artery
precapillary sphincter
capillary network
venule
thoroughfare channel
B
arteriole
arteriovenous anastomosis
sympathetic nerve
venule
ligature
tissue
anatomic end artery
functional end artery
C
inferior vena cava
portal vein
liver
gut
D
bicuspid valve of vein
E

Vein

- Transport blood to heart
- Many of vein posses valve.
- Smallest vein called venules.
- Smaller vein or tributaries, unite to form large vein which join with one another to form venous plexuses.
- Medium-size deep artery accompanied by two vein one each side called venae comitantes.

Capillary:

Are microscpic vessels in the form of network connect the arterioles to venules

Artery → Arteriol → Capillaries → anastomosis → venules → vein

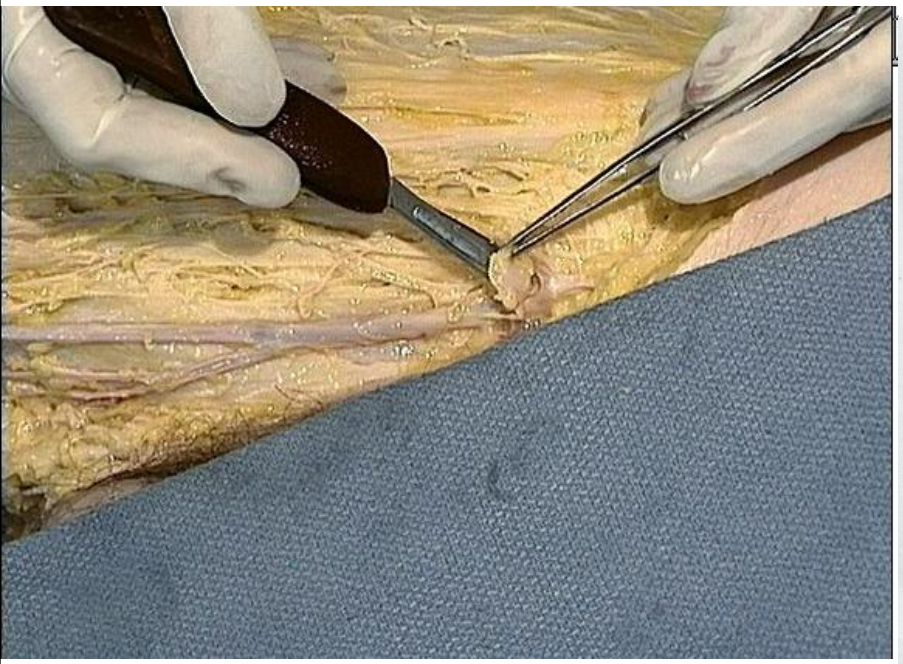
LYMPHATIC SYSTEM:

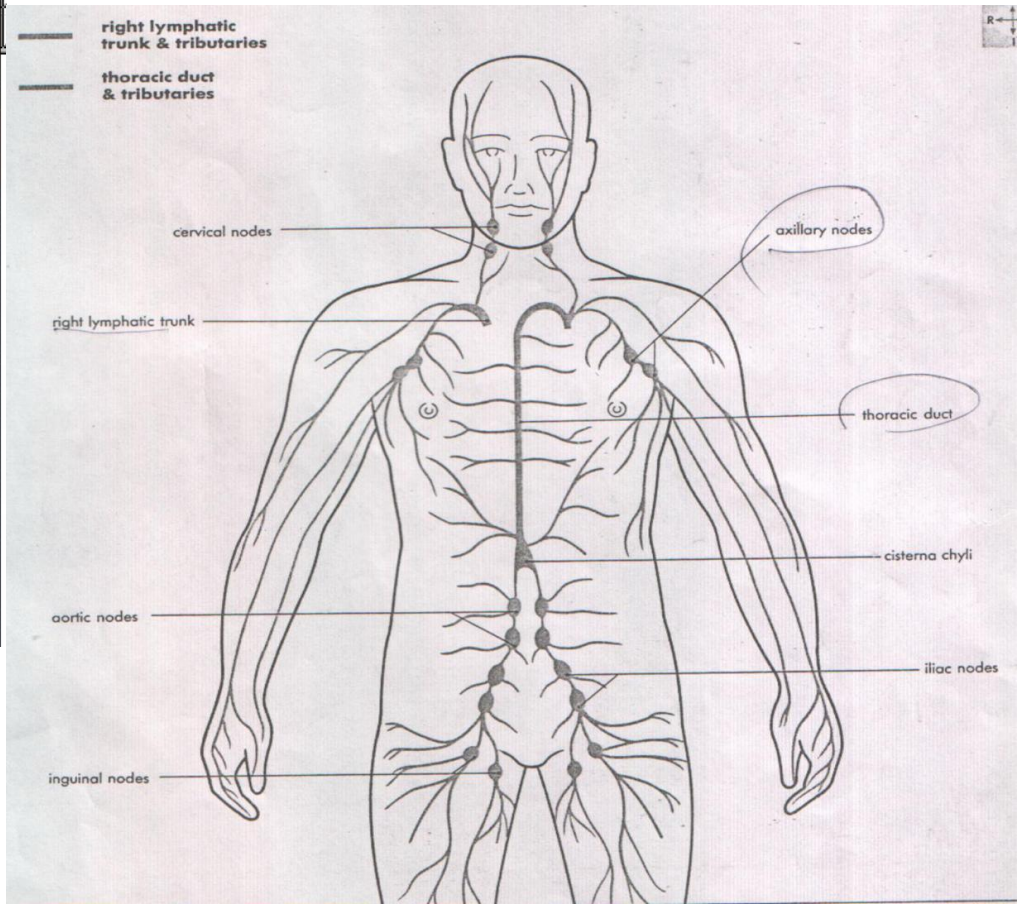
LYMPHATIC TISSUE: are a type of connection tissue that contain large number of lymphocyte , present in thymus , lymph node, spleen , and lymphatic nodules .

LYMPHATIC VESSELS: are tubes that carry tissue fluid from tissue spaces of body, found in an tissues and organ of body returing it to blood . except central nervous system, eyeball, internal ear ,epidermis of skin, cartilage, and bones.

lymph vessels have numerous valves -

Lymph Node: is gland like structure act as filter for lymph containing - phagocyte . varies in size and shape, increase with age , increase in size by inflammation and tumor growth in upper limb found in axilla, in lower limb in groin , most lymph nodes situated close to deep vein , enlargement of lymph node give idea about particular region of the body




right lymphatic trunk & tributaries
thoracic duct & tributaries
cervical nodes
axillary nodes
right lymphatic trunk
thoracic duct
cisterna chyli
aortic nodes
iliac nodes
inguinal nodes

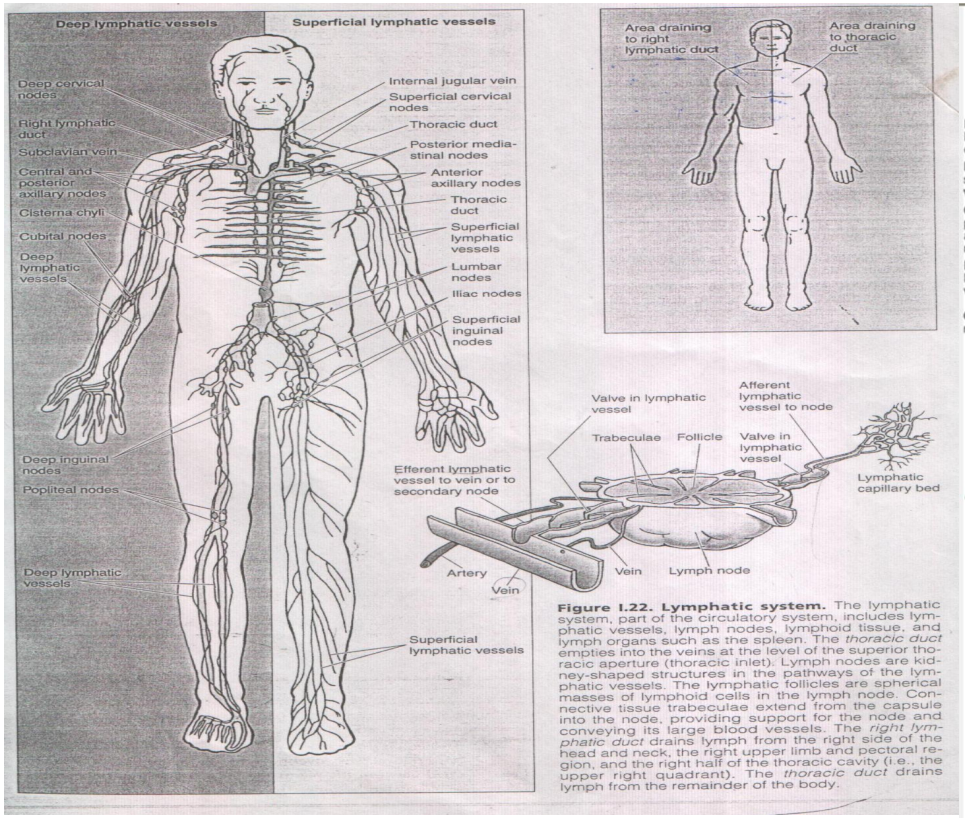
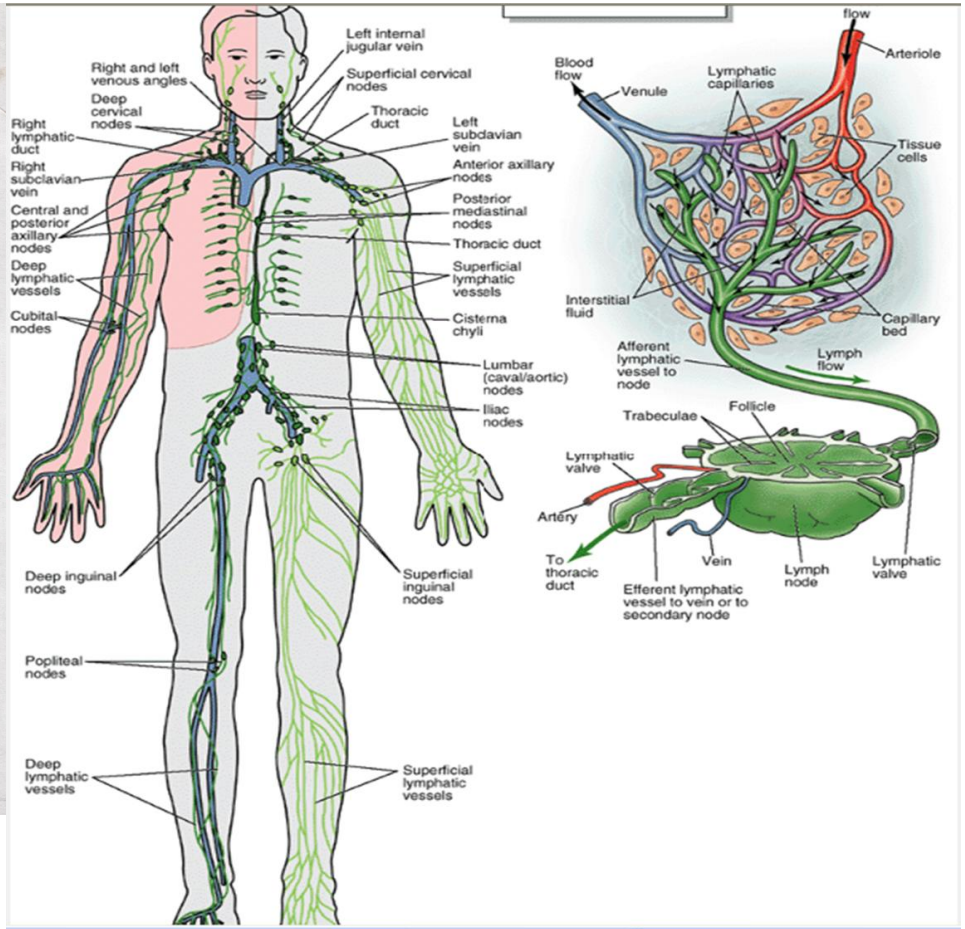


Figure I.22. Lymphatic system. The lymphatic system, part of the circulatory system, includes lymphatic vessels, lymph nodes, lymphoid tissue, and lymph organs such as the spleen. The *thoracic duct* empties into the veins at the level of the superior thoracic aperture (thoracic inlet). Lymph nodes are kidney-shaped structures in the pathways of the lymphatic vessels. The lymphatic follicles are spherical masses of lymphoid cells in the lymph node. Connective tissue trabeculae extend from the capsule into the node, providing support for the node and conveying its large blood vessels. The *right lymphatic duct* drains lymph from the right side of the head and neck, the right upper limb and pectoral region, and the right half of the thoracic cavity (i.e., the upper right quadrant). The *thoracic duct* drains lymph from the remainder of the body.



Ultrastructure of Skin

The skin is the largest organ in the human body and comprises approximately 8% of total body mass.

It is a versatile structure with a wide range of functions; and its exact composition varies across different regions of the body's surface.

In this article, we will discuss the function, gross structure and ultrastructure of our skin.

Functions of Skin

1-The skin provides an essential barrier between the external environment and internal body contents. It protects against mechanical, chemical, osmotic, thermal, and UV damage, and microbial invasion.

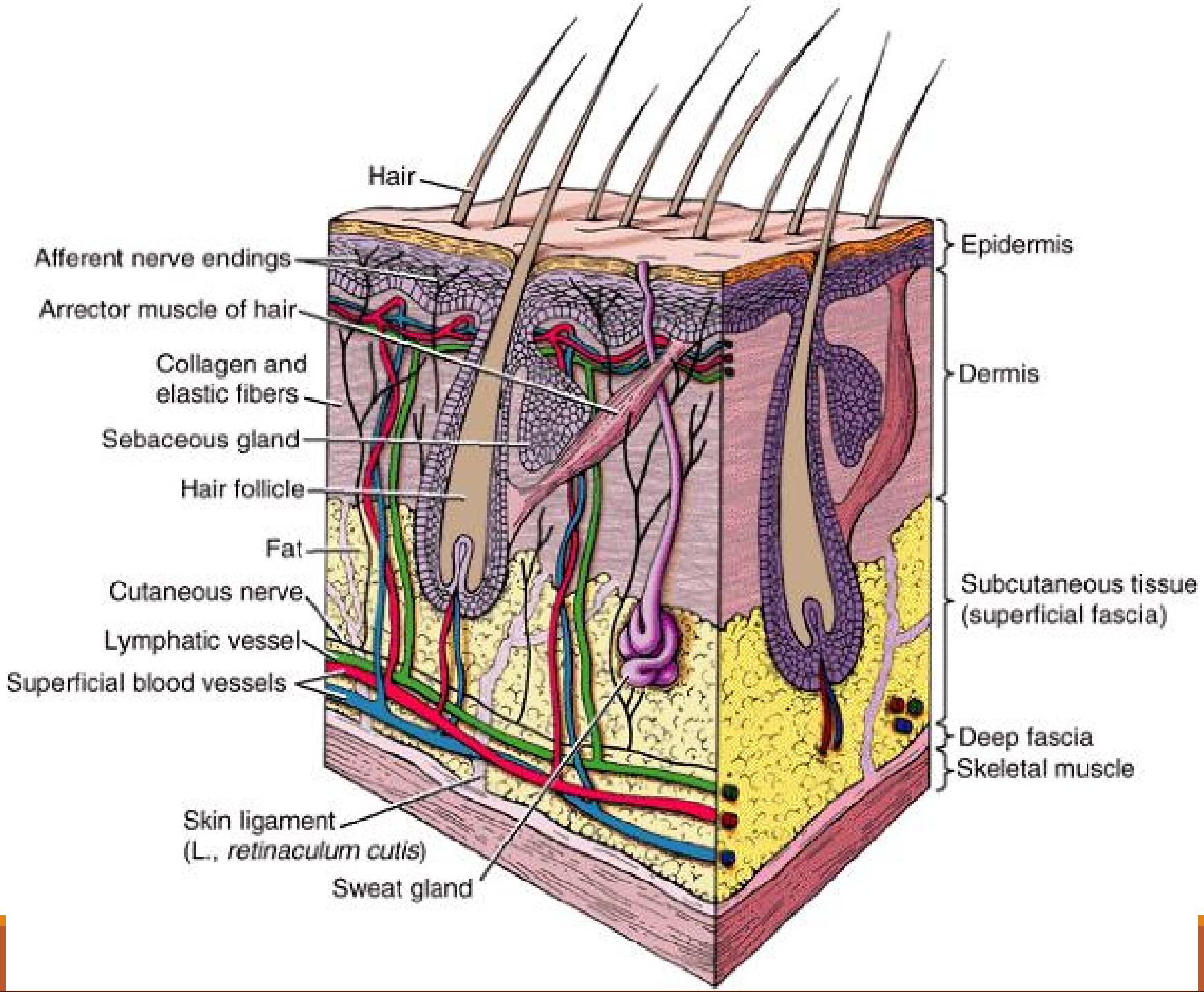
Its other functions include:

2-A role in the synthesis of vitamin D

3-Regulation of body temperature

4-Psychosexual communication

5-A major sensory organ for touch, temperature, pain, and other stimuli.


Hair
Afferent nerve endings
Arrector muscle of hair
Collagen and elastic fibers
Sebaceous gland
Hair follicle
Fat
Cutaneous nerve
Lymphatic vessel
Superficial blood vessels
Skin ligament (L., *retinaculum cutis*)
Sweat gland
Epidermis
Dermis
Subcutaneous tissue (superficial fascia)
Deep fascia
Skeletal muscle

Gross Structure

The composition of skin varies across the surface of the body. Skin can be thin, hairy, hirsute, or glabrous. Glabrous skin is the thick skin found over the palms, soles of the feet and flexor surfaces of the fingers that is free from hair. Throughout the body, skin is composed of three layers; **the epider**mis, dermis and hypodermis. We shall now examine these layers in more detail.

Epidermis

The epidermis is the most superficial layer of the skin, and is largely formed by layers of keratinocytes undergoing terminal maturation. This involves increased keratin production and migration toward the external surface, a process termed cornification.

Layers of the Epidermis

The epidermis can be divided into layers (strata) of keratinocytes – this reflects their change in structure and properties as they migrate towards the surface. From deepest to most superficial, these layers are:

1-Stratum basale – mitosis of keratinocytes occurs in this layer.

2-Stratum spinosum – keratinocytes are joined by tight intercellular junctions called desmosomes.

3-Stratum granulosum – cells secrete lipids and other waterproofing molecules in this layer.

4-Stratum lucidum – cells lose nuclei and drastically increase keratin production.

5-Stratum corneum – cells lose all organelles, continue to produce keratin.

A keratinocyte typically takes between 30 – 40 days to travel from the stratum basale to the stratum corneum.

Dermis

The dermis is immediately deep to the epidermis and is tightly connected to it through a highly-corrugated dermo-epidermal junction.

The dermis has only two layers, which are less clearly defined than the layers of the epidermis.

They are the superficial papillary layer, and the deeper reticular layer. The reticular layer is considerably thicker, and features thicker bundles of collagen fibers that provide more durability.

The following cell types and structures can be found in the dermis:

1-Fibroblasts – these cells synthesize the extracellular matrix, which is predominantly composed of collagen and elastin.

2-Mast cells – these are histamine granule-containing cells of the innate immune system.

3-Blood vessels and cutaneous sensory nerves

4-Skin appendages – e.g. hair follicles, nails, sebaceous and sweat glands. Although present in the dermis, these structures are **derived from the epidermis** which **descend** into the dermis during development.

Hair Follicles and Sebaceous Glands

The hair follicles and sebaceous glands combine to form a pilosebaceous unit – which is only found on hirsute skin.

Sebaceous glands release their glandular secretions into the hair follicle shaft. The hair follicle itself is associated with an arrector pili muscle, which contracts to cause the follicle to stand upright.

Sweat Glands

There are two main types of sweat glands:

Eccrine glands – the major sweat glands of the human body. They release a clear, odourless substance, comprised mostly of sodium chloride and water – which is involved in thermoregulation.

Apocrine glands – larger sweat glands, located in the axillary and genital regions. These apocrine glandular products can be broken down by cutaneous microbes, producing body odour.

Hypodermis

The hypodermis, or subcutaneous tissue, is immediately deep to the dermis.

It is a major body store of adipose tissue, and as such can vary in size between individuals depending on the amount of fatty tissue present.

Muscle Tissue and the Muscular System

The muscular system consists of all the muscles of the body. Although the muscles of the muscular system are all composed of one specific type of muscle tissue, other types of muscle tissue form important components of the organs of other systems, including the cardiovascular, digestive, genitourinary, and integumentary systems.

Types of Muscle (Muscle Tissue)

Muscle cells, often called muscle fibers because they are long and narrow when relaxed, are specialized contractile cells. They are organized into tissues that move body parts or temporarily alter the shape (reduce the circumference of all or part) of internal organs.

. Three types of muscle are described based on distinct characteristics relating to:

- Whether it is normally willfully controlled (voluntary vs. involuntary).
- Whether it appears striped or unstriped when viewed under a microscope (striated vs. smooth or unstriated).
- Whether it is located in the body wall and limbs or makes up the hollow organs (viscera) of the body cavities or blood vessels (somatic vs. visceral).

The Three Muscle Types Are

1-Skeletal striated muscle is voluntary somatic muscle that makes up the gross skeletal muscles that compose the muscular system, moving or stabilizing bones and other structures (e.g., the eyeballs).

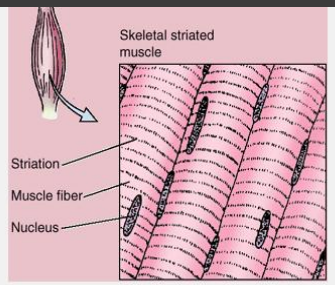
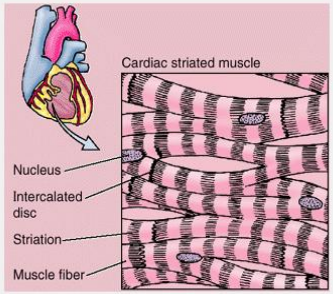
2-Cardiac striated muscle is involuntary visceral muscle that forms most of the walls of the heart and adjacent parts of the great vessels, such as the aorta, and pumps blood.

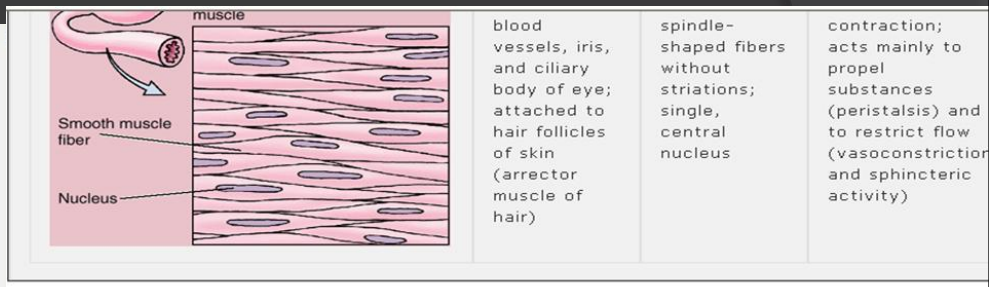
3-Smooth muscle (unstriated or unstriped muscle) is involuntary visceral muscle that forms part of the walls of most vessels and hollow organs (viscera), moving substances through them by coordinated sequential contractions (pulsations or peristaltic contractions).

1-Skeletal Muscles Form, Features, and the Naming of Muscles:

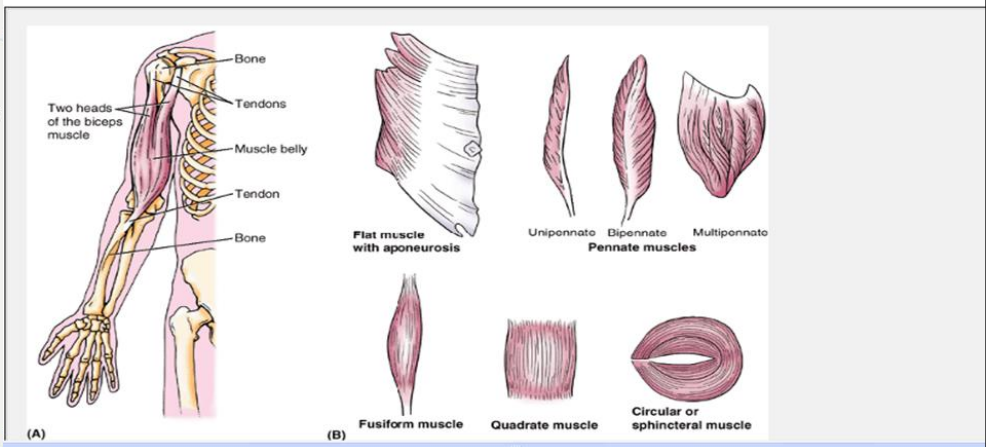
All skeletal muscles, commonly referred to simply as muscles, have fleshy, reddish, contractile portions (one or more heads or bellies) composed of skeletal striated muscle. Some muscles are fleshy throughout, but most also have white non-contractile portions (tendons), composed mainly of organized collagen bundles, that provide a means of attachment . When referring to the length of a muscle, both the belly and the tendons are included. In other words, a muscle's length is the distance between its attachments. Most skeletal muscles are attached directly or indirectly to bones, cartilages, ligaments, or fascias or to some combination of these structures. Some muscles are attached to organs (the eyeball, for example), skin (such as facial muscles), and mucous membranes (intrinsic tongue muscles). Muscles are organs of locomotion (movement), but they also provide static support, give form to the body, and provide heat. The architecture and shape of muscles vary . The tendons of some muscles form flat sheets, or aponeuroses, that anchor the muscle to the skeleton (usually a ridge or a series of spinous processes) and/or to deep fascia (such as the latissimus dorsi muscle), or to the aponeurosis of another muscle (such as the oblique muscles of the anterolateral abdominal wall). Most muscles are named on the basis of their function or the bones to which they are attached. The abductor digiti minimi muscle, for example, abducts the little finger. The sternocleidomastoid muscle (G., kleidos, bolt or bar, clavicle) attaches inferiorly to the sternum and clavicle and superiorly to the mastoid process of the temporal bone of the cranium. Other muscles are named on the basis of their position (medial, lateral, anterior, posterior) or length (brevis, short; longus, long). Muscles may be described or classified according to their shape, for which a muscle may also be named

Table 1

	gross, named muscles (e.g., biceps of arm) attached to skeleton and fascia of limbs, body wall, and head/neck	long, unbranched, cylindrical fibers with transverse striations (stripes) arranged in parallel bundles; multiple, peripherally located nuclei	intermittent (phasic) contraction above a baseline tonus; acts primarily to produce movement or resist gravity	reflexive) by somatic nervous system
	Muscle of heart (myocardium) and adjacent portions of great vessels (aorta, vena cava)	Branching and anastomosing shorter fibers with transverse striations (stripes) running parallel and connected end to end by complex junctions (intercalated discs); single, central nucleus	Strong, quick, continuous rhythmic contraction; acts to pump blood from heart	Involuntary; intrinsically (myogenically) stimulated and propagated; rate and strength of contraction modified by autonomic nervous system



blood vessels, iris, and ciliary body of eye; attached to hair follicles of skin (arrector muscle of hair)	spindle-shaped fibers without striations; single, central nucleus	contraction; acts mainly to propel substances (peristalsis) and to restrict flow (vasoconstriction and sphincteric activity)



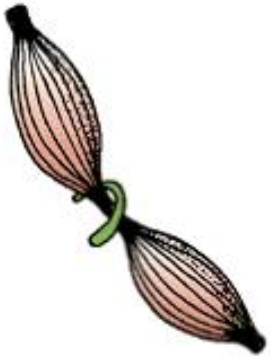
- Flat muscles have parallel fibers often with an aponeurosis for example, external oblique.
- Pennate muscles are feather-like (L. pennatus, feather) in the arrangement of their fascicles, and may be unipennate, bipennate, or multi-pennate for example, extensor digitorum longus (unipennate), bellies of the gastrocnemius (bipennate), and deltoid (multi-pennate).
- Fusiform muscles are spindle shaped with a round, thick belly (or bellies) and tapered ends for example, biceps brachii.
- Quadrate muscles have four equal sides (L. quadratus, square) for example, pronator quadratus.
- Circular or sphincteral muscles surround a body opening or orifice, constricting it when contracted for example, orbicularis oris (closes the mouth).
- Multi-headed or multi-bellied muscles have more than one head of attachment or more than one contractile belly, respectively for examples, biceps muscles (biceps brachii) have two heads of attachment, triceps muscles have three heads (triceps brachii), and the digastric and gastrocnemius muscles have two bellies (those of the former are tandem; those of the latter, parallel).

quadrilateral


strap

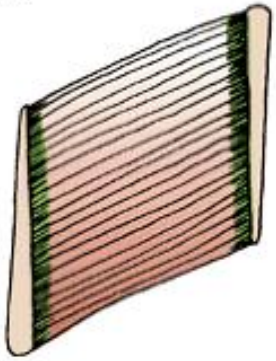

strap with tendinous intersections


fusiform


two bellies

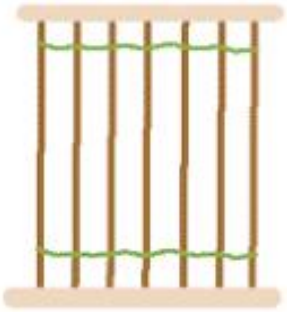

two hea


triangular


unipennate


bipennate


multipennate


relaxed


contracted

Cardiac Striated Muscle

Cardiac striated muscle forms the muscular wall of the heart, the myocardium. Some cardiac muscle is also present in the walls of the aorta, pulmonary vein, and superior vena cava (SVC). Cardiac striated muscle contractions are not under voluntary control.). Cardiac striated muscle has a distinctly striped appearance under microscopy (Table I.1). Both types of striated muscle skeletal and cardiac are further characterized by the immediacy, rapidity, and strength of their contractions. Cardiac muscle is distinct from skeletal muscle in both behavior and appearance.

1-Unlike striated skeletal muscle fibers, cardiac muscle fibers: Contract spontaneously (without extrinsic stimuli) and rhythmically.

2-Bifurcate (split or branch).

3-Are traversed at intervals by intercalated discs (disks) unique, specialized end-to-end junctions where they are linked into a chain or mesh with other bifurcating cardiac muscle fibers.

4-To support its continuous level of high activity, the blood supply to cardiac muscle is twice as rich as that to skeletal muscle.

Smooth Muscle

Smooth ~~muscle, named for the absence of striations in the appearance of the muscle~~ fibers under microscopy, forms a large part of the middle coat or layer (tunica media) of the walls of blood vessels (above the capillary level) (Table I.1). Consequently, it occurs in all vascularized tissue.

- It also makes up the muscular part of the walls of the digestive tract and ducts.
- Smooth muscle is found in skin, composing the arrector muscle of hair associated with hair follicles ,
- and in the eyeball, where it controls lens thickness and pupil size.
- Like cardiac striated muscle, smooth muscle is involuntary muscle; however, it is directly innervated by the ANS. Its contraction can also be initiated by **hormonal stimulation or by local stimuli**, such **as stretching**. Smooth muscle responds more slowly than striated muscle and with a delayed and more leisurely contraction. It can undergo partial contraction for long periods and has a much greater ability than striated muscle to elongate without suffering paralyzing injury. Both of these factors are important in regulating the size of sphincters and the caliber of the lumina (interior spaces) of tubular structures. In the walls of the digestive tract, uterine tubes, and ureters, smooth muscle cells are responsible for peristalsis, rhythmic contractions that propel the contents along these tubular structures.

Functions of Muscles

Muscles serve specific functions in moving and positioning the body.

A prime mover or agonist is the main muscle responsible for producing a specific movement of the body. It contracts concentrically to produce the desired movement, doing most of the work (expending most of the energy) required. In most movements, there is a single prime mover, but some movements involve two prime movers working in equal measure.

Fixators steady proximal parts of a limb through isometric contraction while movements are occurring in distal parts.

A synergist complements the action of a prime mover. It may directly assist a prime mover, providing a weaker or less mechanically advantaged component of the same movement, or it may assist indirectly, by serving as a fixator of an intervening joint when a prime mover passes over more than one joint, for example. It is not unusual to have several synergists assisting a prime mover in a particular movement.

An antagonist is a muscle that opposes the action of another muscle. A primary antagonist directly opposes the prime mover, but synergists may also be opposed by secondary antagonists. As the active movers concentrically contract to produce a movement, antagonists eccentrically contract, relaxing progressively in coordination to produce a smooth movement.

The end