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YMCA College of Physical Education

Anatomy and Physiology

Cell Biology

All living things are made up of cells'. 'The cell is the basic unit of structure and function'. These generalised statements are known as Cell theory. This theory was forwarded by Mathias Schleiden and Theodor Schwann in 1838 - 39.

Today the cell theory includes four more ideas : the cells are the building block of structures in living things the cell is derived from other cells by division the cell contains information that is used as instructions for growth, development and functioning the cell is the functioning unit of life; the chemical reactions of life take place within cells.

The idea and concept of cell biology evolved during the 19th century as a result of gradual advancement in the field of microscopy and biochemistry. Today the study of the structure of cells (cytology) is part of a major branch of biology known as cell biology. Due to its wide application many new branches have sprung up in biology.

Some of the new branches related to cytology are, Cytotaxonomy, Cytogenetics, Cell physiology, Cytochemistry, Molecular Biology, Cytopathology and Cytoecology.

Human Anatomy

History of Human anatomy

The term ‘anatomy’ is Greek in origin. It takes its root from ‘ana’ and ‘tome’ (ana-up ; tome-cutting). Thus anatomy is the science of physical structure of an animal or plant studied by dissection. The Human Anatomy provided the necessary knowledge for surgery and medicine. The study of human anatomy dates back to 2500 BC, when the Egyptians prepared mummies.

They removed internal organs of cadavers being mummified. They also did surgery for wounds and broken bones. In India during 500 - 491 BC Susruta performed cataract operation. In 1st century AD, Celsus, a Roman physician wrote about surgical procedures.

The year 1543 AD was significant due to publication of an accurate book on Anatomy by Andreas Vesalius. In 1628 William Harvey described the functioning of heart and the movement of blood in animals. These earlier works were followed by the discovery and accurate account of each and every organ system and organs in human body. In the recent times, attempts are being made to understand the molecular architecture in every cell of our body.

They are

1. Integumentary System,
2. Skeletal System
3. Muscular System
4. Nervous System
5. Endocrine System
6. Cardiovascular System
7. Lymphatic System
8. Respiratory System
9. Digestive System
10. Urinary System
11. Reproductive System (Female and Male).

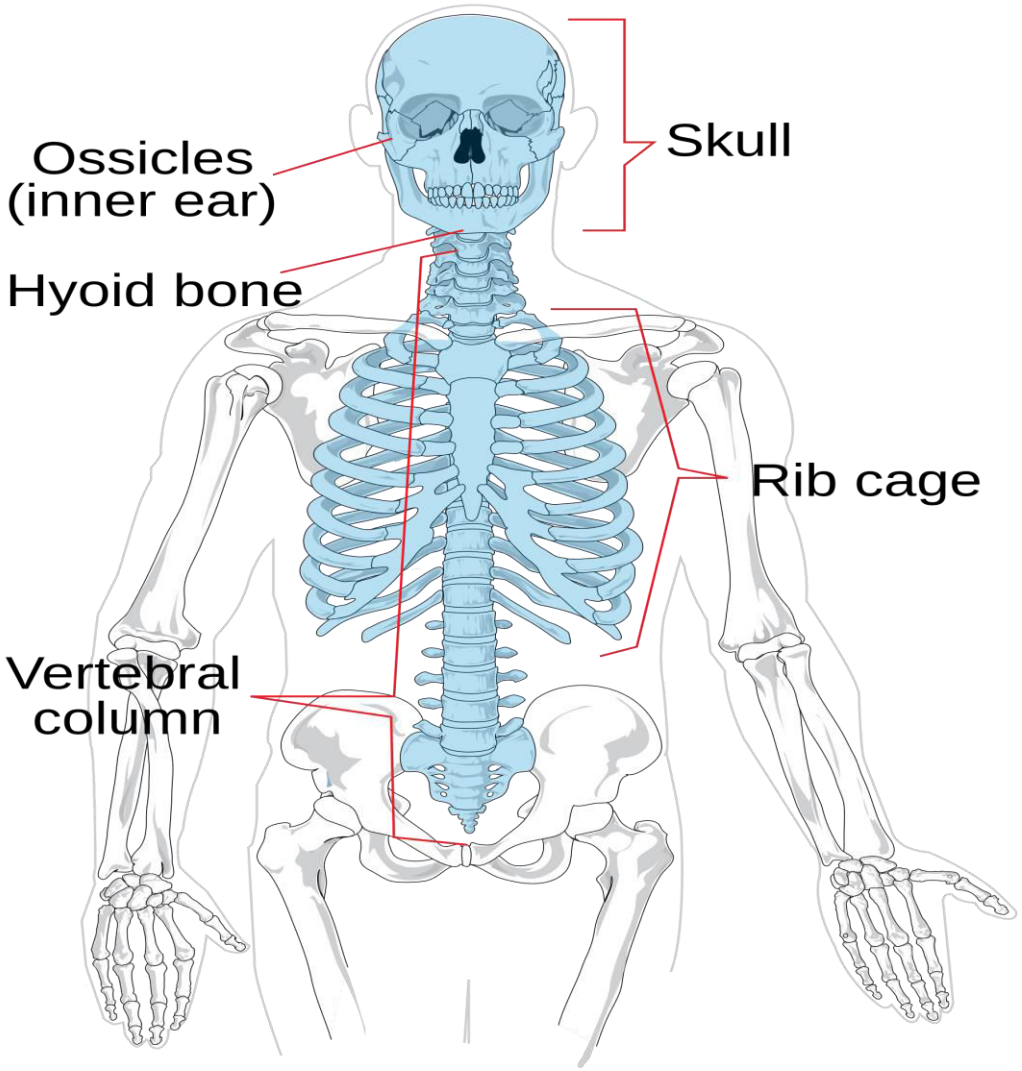
Skeletal system

- The skeletal system is constituted by bones, cartilages and ligaments. This system provides ‘the shape’ to the body. Further, bones remain as regions for the attachment of muscles. It also helps to hold weight. Structures like skull, protect inner organs. This system is also useful in locomotion. The bones remain as reservoirs of fat and certain minerals.

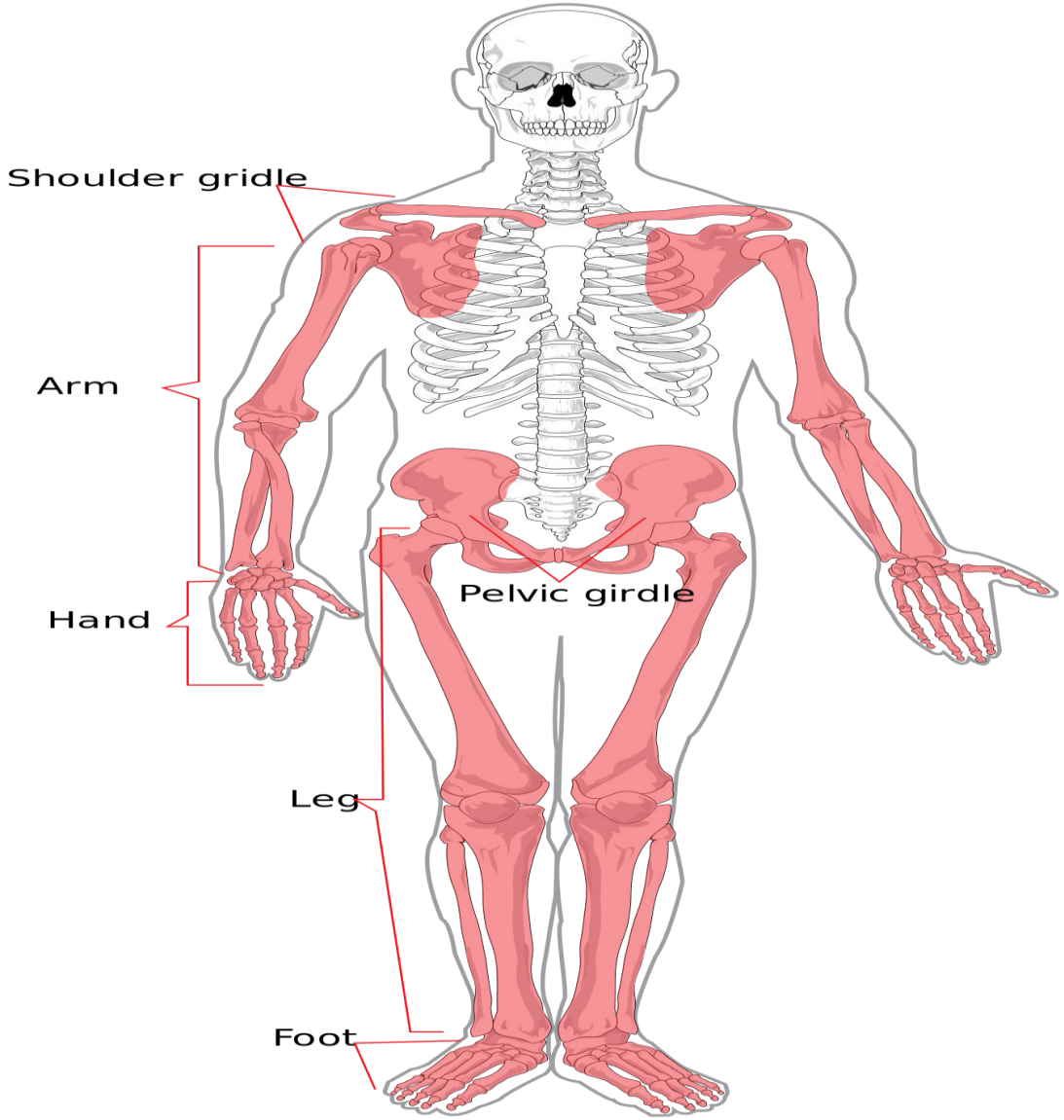
List of bones of the human skeleton

The skeleton of an adult human consists of 206 bones. It is composed of 270 bones at birth, which decreases to 80 bones in the axial skeleton (28 in the skull and 52 in the torso) and 126 bones in the appendicular skeleton (32 × 2 in the upper extremities including both arms and 31 × 2 in the lower extremities including both legs). Many small and often variable bones, such as some sesamoid bones, are not included in this count.

The **axial skeleton** is the part of the skeleton that consists of the bones of the head and trunk of a vertebrate. In the human skeleton, it consists of 80 bones and is composed of six parts

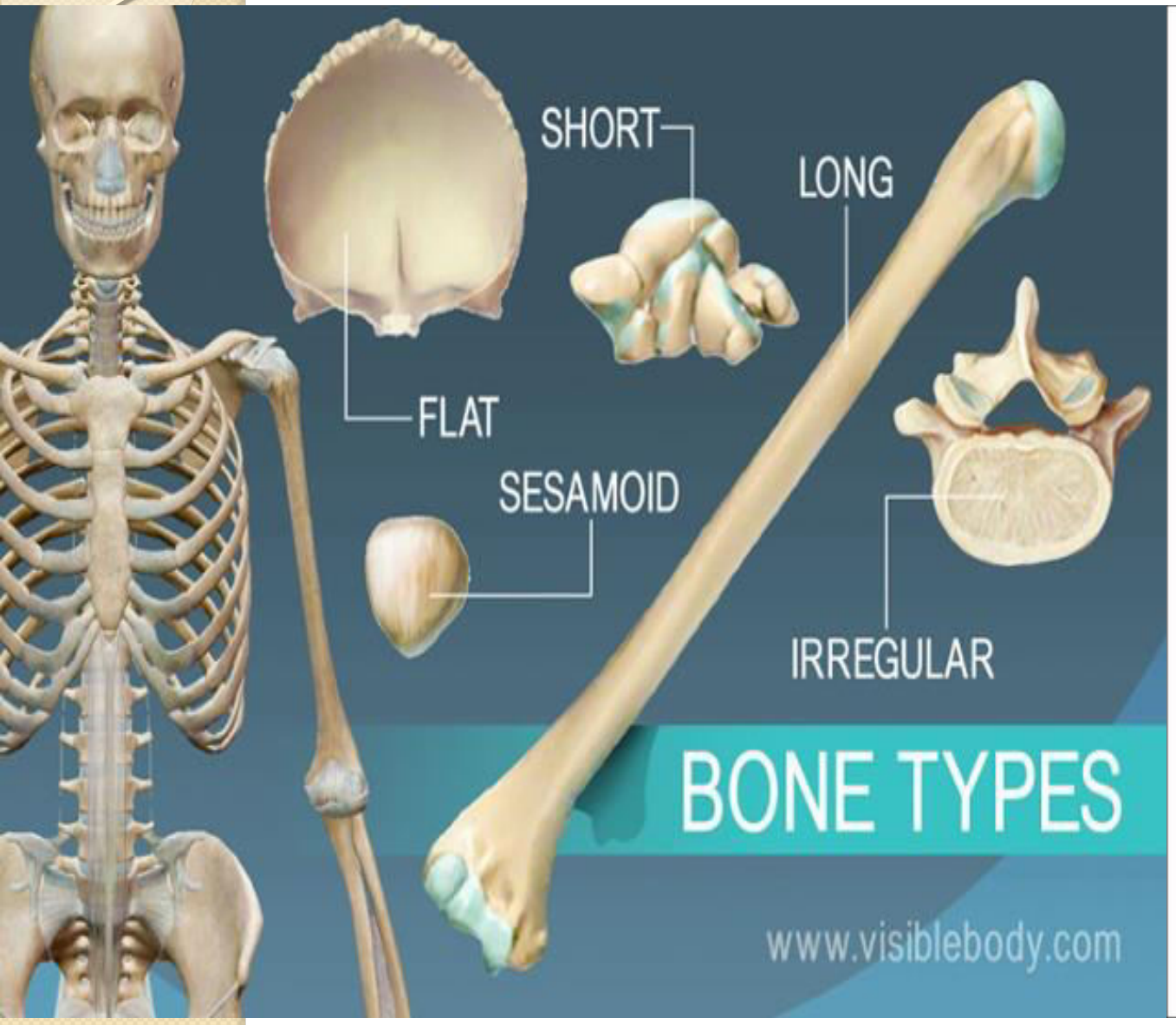


The **appendicular skeleton** is the portion of the skeleton of vertebrates consisting of the bones or cartilage that support the appendages



Types of bones

1) Long bones that is much longer than its width; a rounded head at each end of the shaft. Most bones of the limbs, including those of the fingers and toes, are long bones. Long bones such as the clavicle, that have a differently shaped shaft or ends are also called *modified long bones*.
2) Short bones are roughly cube-shaped, and have only a thin layer of compact bone surrounding a spongy interior. The bones of the wrist and ankle are short bones.
3) Flat bones are thin and generally curved, with two parallel layers of compact bones sandwiching a layer of spongy bone. Most of the bones of the skull are flat bones, as is the sternum.
4) Sesamoid bones are bones embedded in tendons. Since they act to hold the tendon further away from the joint. Examples of sesamoid bones are the patella and the pisiform.
5) Irregular bones do not fit into the above categories, their shapes are irregular and complicated. Often this irregular shape is due to their many centers of ossification or because they contain bony sinuses. The bones of the spine, pelvis, and some bones



Types of Bones

Long bones are longer than they are wide and the muscles act on them as rigid levers

+ long bone

Short bones are equal in width and length and clued across one another

short bone

Irregular bones are typically neither flat nor long

irregular bone

Flat bones protect soft organs and are curved

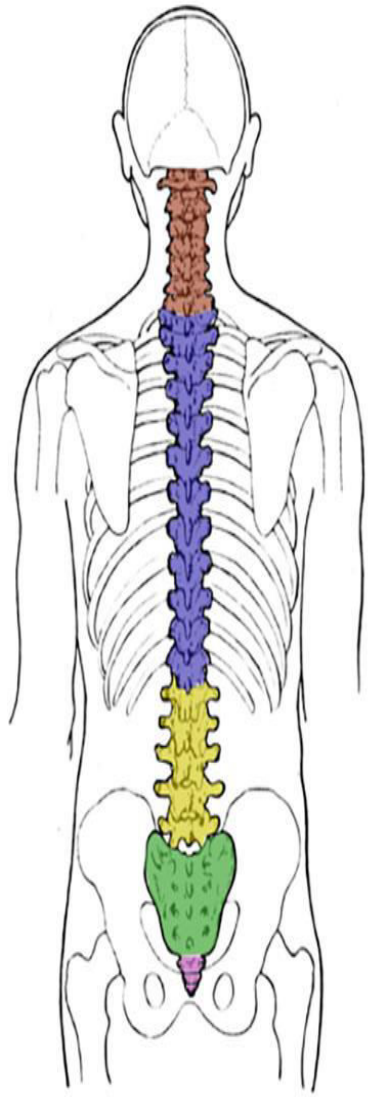
flat bone

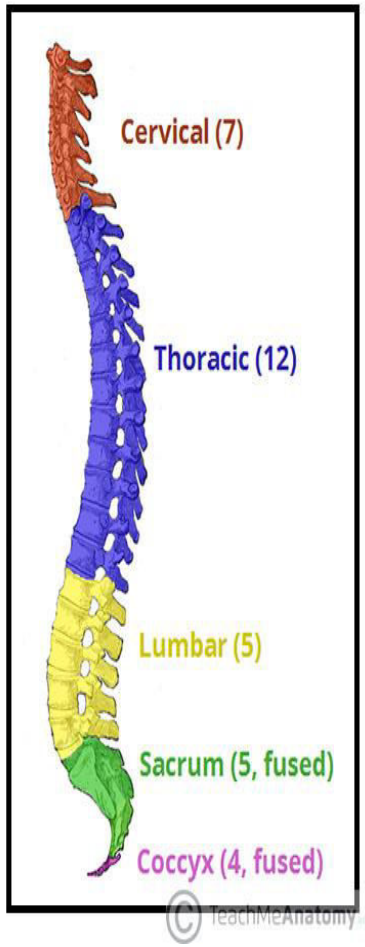
- Functions ofBone**Mechanical**Protection
- Gives structure
- Facilitates movement
- Facilitates hearing
- **Synthetic**Contains bone marrow
- **Metabolic**Stores calcium
- Helps regulate the acid-base bala

Spine (vertebral column)

A fully grown adult features 26 bones in the spine, whereas a child can have 34.

- The cervical vertebrae (7)
- The thoracic vertebrae (12)
- The lumbar vertebrae (5)
- The sacral vertebrae (5 at birth, later fused into one)
- The coccygeal vertebrae (5 at birth, some or all of the bones fuse together but there seems to be a disagreement between researchers as to what the most common number should be.

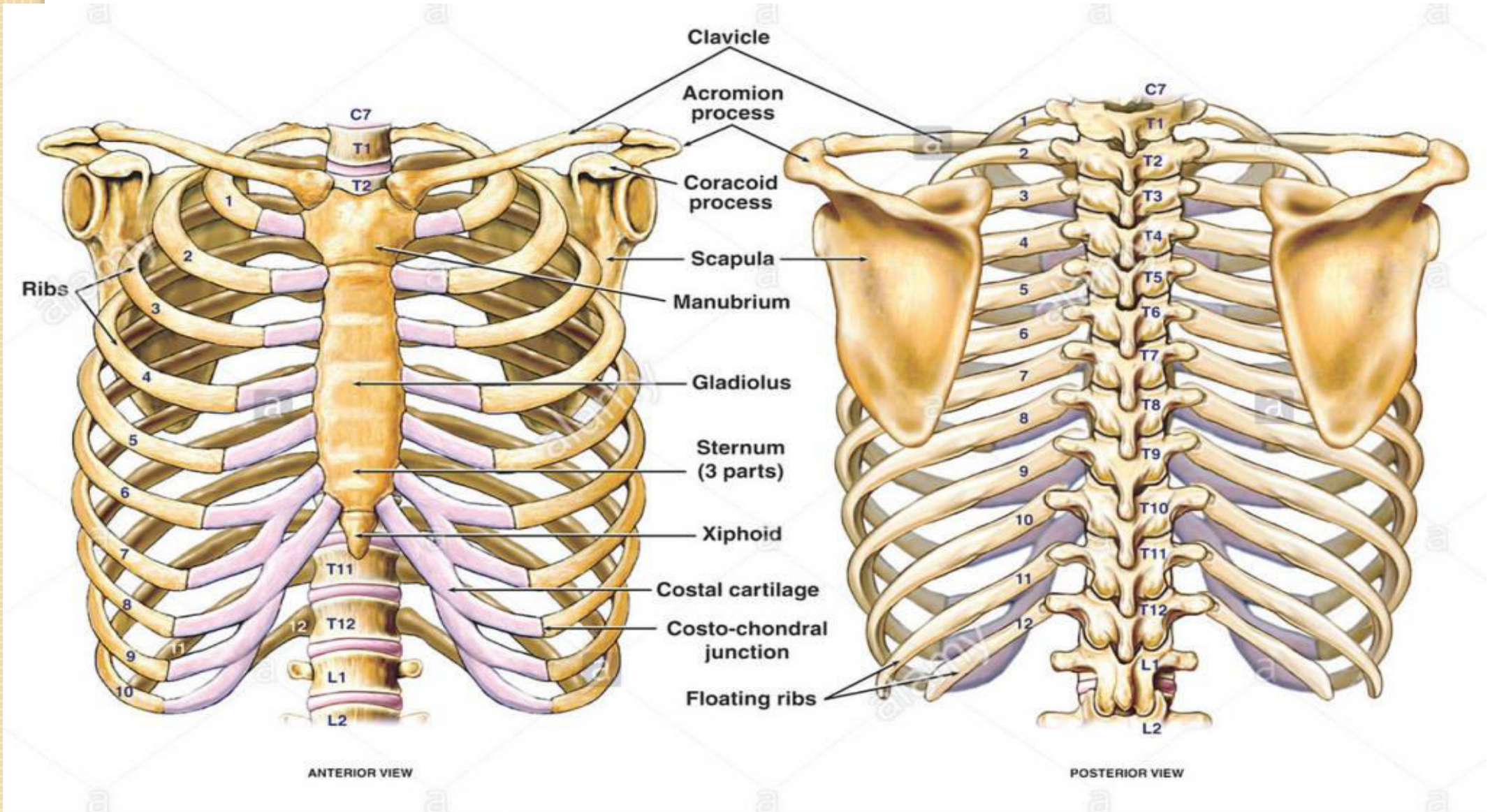




Chest (thorax)

There are usually 25 bones in the chest but sometimes there can be additional cervical ribs in humans. Cervical ribs occur naturally in other animals such as reptiles.

- The sternum (1)
- The ribs (24, in 12 pairs)
  - It is important to note that three pairs (the 8th, 9th and 10th), also known as false ribs, are attached to each other. They are also attached to the 7th rib by cartilage and synovial joints. Also two pairs of floating ribs (the 11th and 12th), have no anterior attachment.
  - Cervical ribs are extra ribs that occur in some humans.



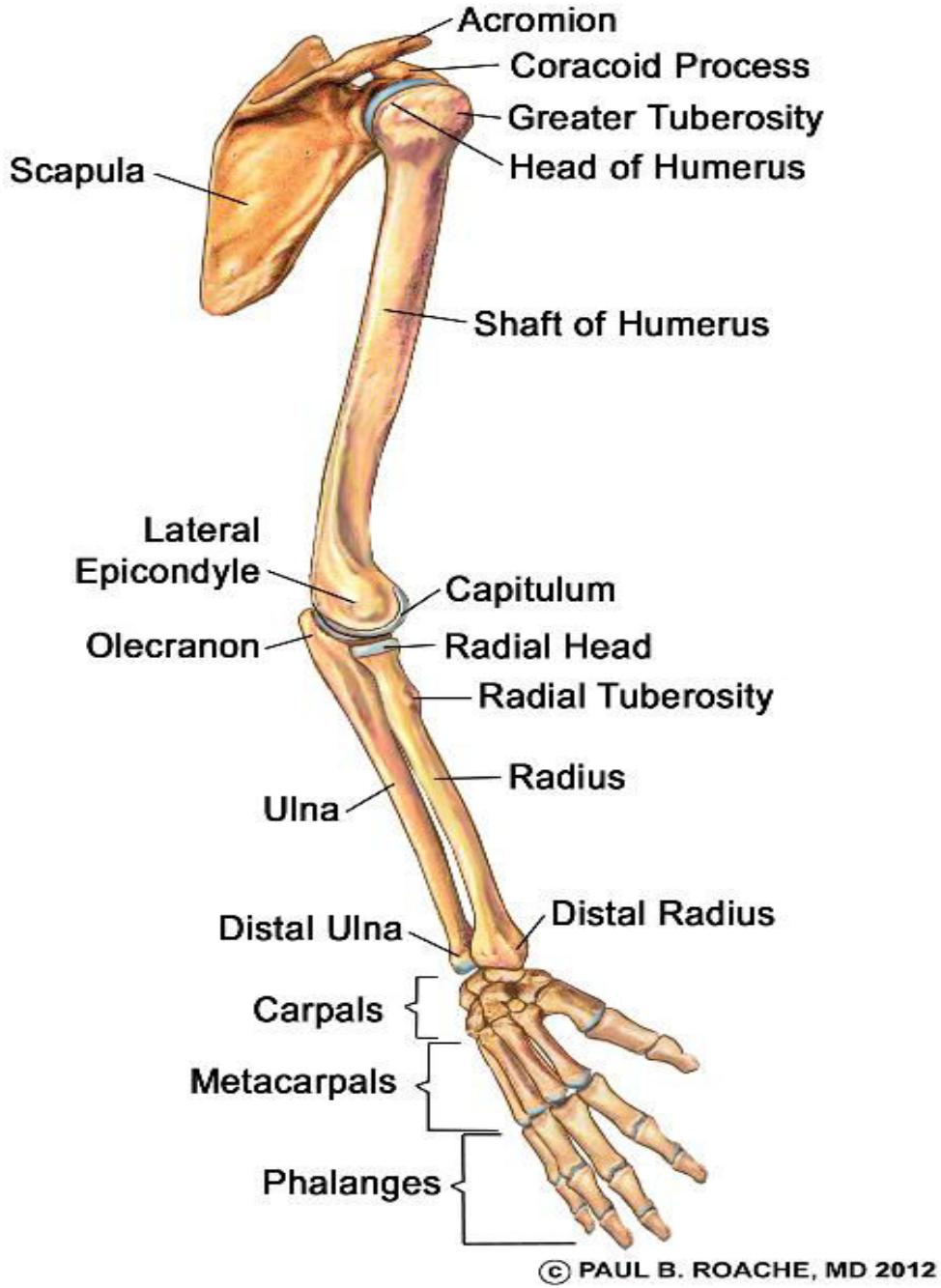
Arm

There are a total of 64 bones in the arm.

- The upper arm bones (6 bones, 3 on each side)
  - The humerus
  - The shoulder (pectoral girdle)
    - The scapula
    - The clavicles
- The lower arm bones (4 bones, 2 on each side)
  - The ulna
  - The radius
- The hand (54 bones, 27 in each hand)
  - The carpals
    - scaphoid bone (2)
    - lunate bone (2)
    - triquetral bone (2)
    - pisiform bone (2)
    - trapezium (2)
    - trapezoid bone (2)
    - capitate bone (2)
    - hamate bone (2)
    - The metacarpals (5 × 2 = 1
    - The phalanges of the hand
    - proximal phalanges (5 × 2 = 10)
    - intermediate phalanges (4 × 2 = 8)
    - distal phalanges (5 × 2 = 10)

Leg

- The femur (2)
- The patella or kneecap (2)
- The tibia (2)
- The fibula (2)
- The foot (52 bones in total, 26 per foot)
  - The tarsus
    - calcaneus or heel bone (2)
    - talus (2)
    - navicular bone (2)
    - medial cuneiform bone (2)
    - intermediate cuneiform bone (2)
    - lateral cuneiform bone (2)
    - cuboid bone (2)
  - The metatarsals (10)
  - The phalanges of the foot
    - proximal phalanges (5 × 2 = 10)
    - intermediate phalanges (4 x 2 = 8)
    - distal phalanges (5 x 2 = 10)


Acromion
Coracoid Process
Greater Tuberosity
Head of Humerus
Scapula
Shaft of Humerus
Lateral Epicondyle
Capitulum
Olecranon
Radial Head
Radial Tuberosity
Radius
Ulna
Distal Ulna
Distal Radius
Carpals
Metacarpals
Phalanges
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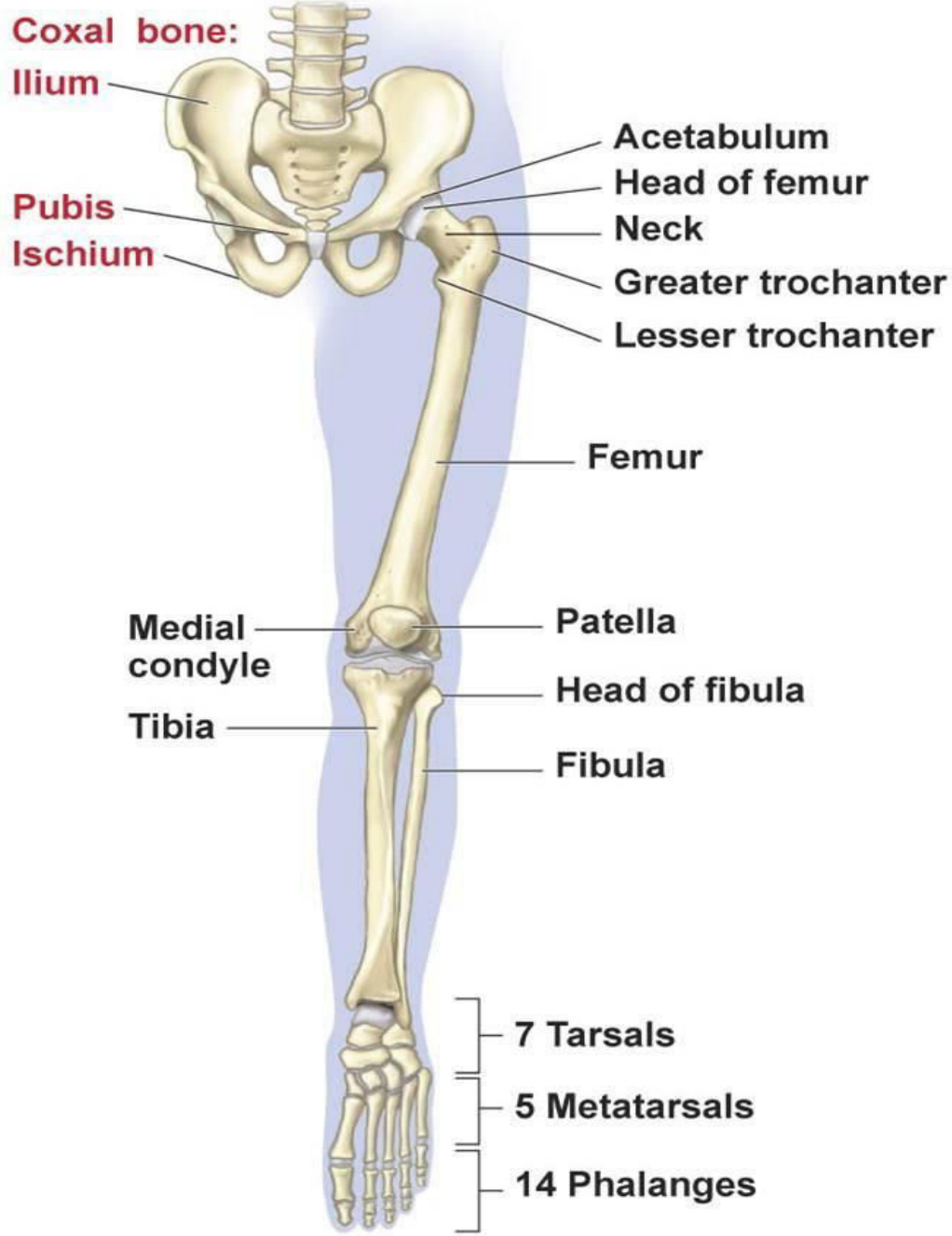
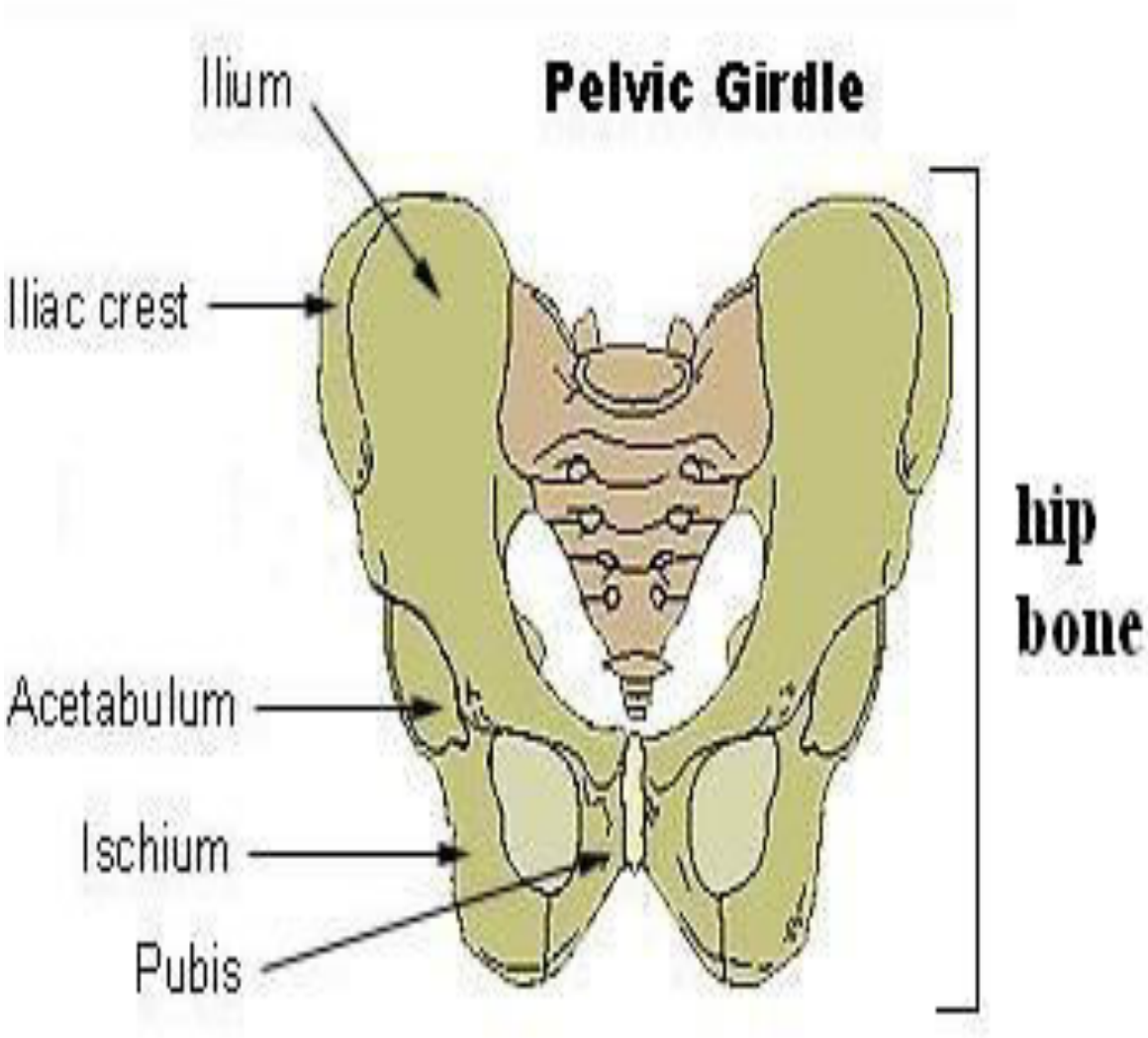

Coxal bone:
Ilium
Pubis
Ischium
Acetabulum
Head of femur
Neck
Greater trochanter
Lesser trochanter
Femur
Medial condyle
Patella
Head of fibula
Tibia
Fibula
7 Tarsals
5 Metatarsals
14 Phalanges

Pelvis (pelvic girdle)

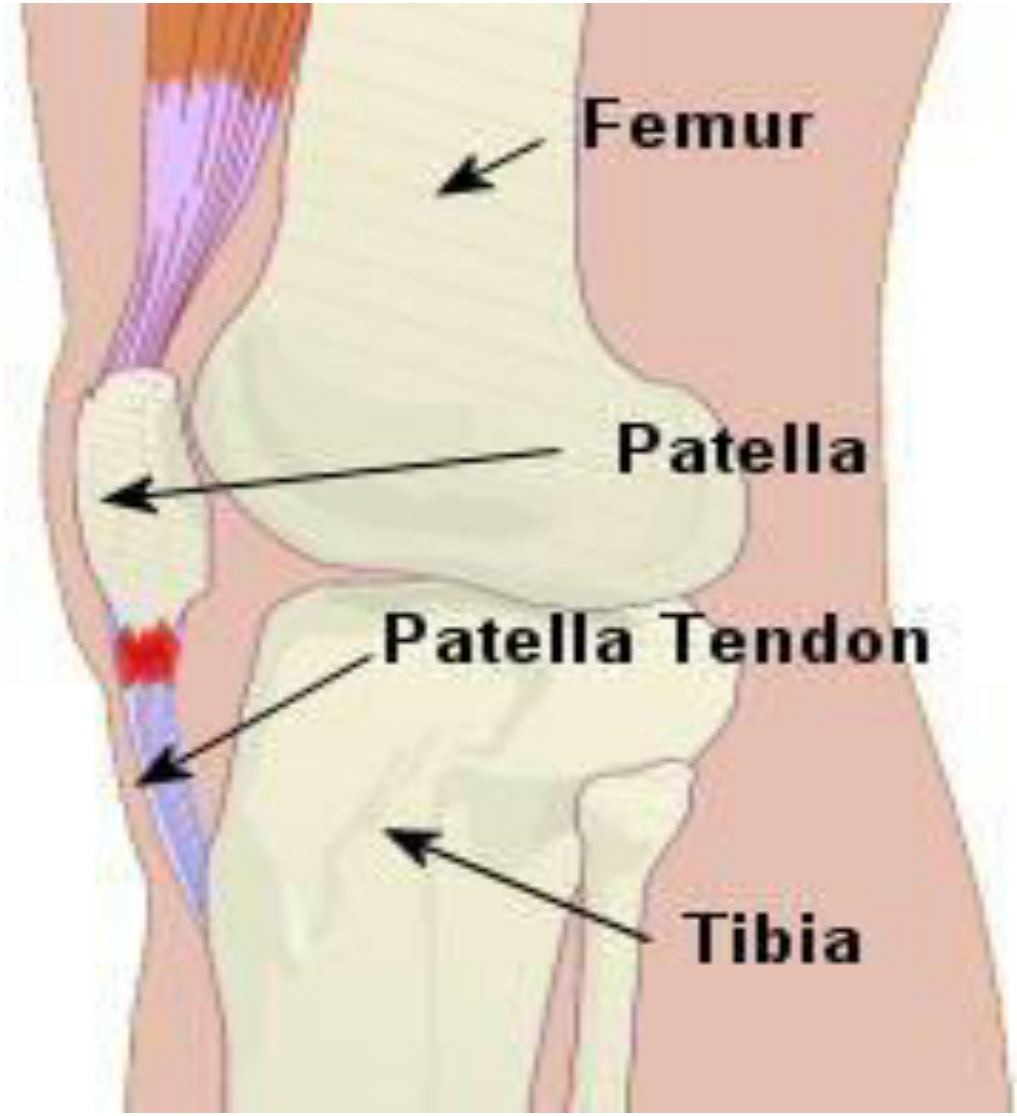
The hip bone has three regions:
ilium, ischium, and pubis (2)

•The sacrum and the coccyx attach to the two hip bones to form the pelvis, but are more important to the spinal column. For this reason it is omitted from the pelvic girdle.



Sesamoid bones

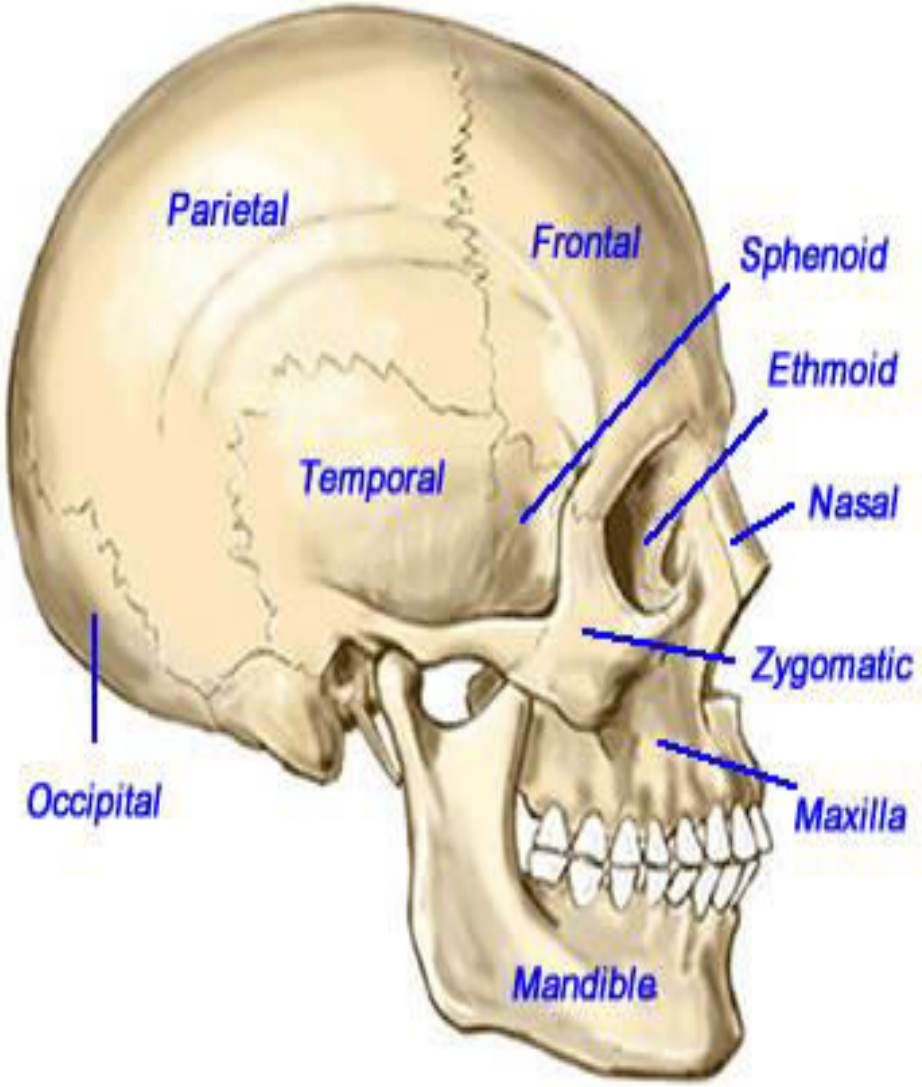
- Patella
- Pisiform bone
- Fabella
- Cyamella (bone)
- Sesamoids in the first and second metacarpa bones
- Sesamoids in the first metatarsal bone
- Inconsistent sesamoids in other fingers and toes
- Lenticular process of the incus
- Rider's bone
- Inconsistent sesamoids in the legs, arms or buttocks



Skull (cranium)

There are 22 bones in the skull. Including the hyoid and the bones of the middle ear, the head contains 29 bones.

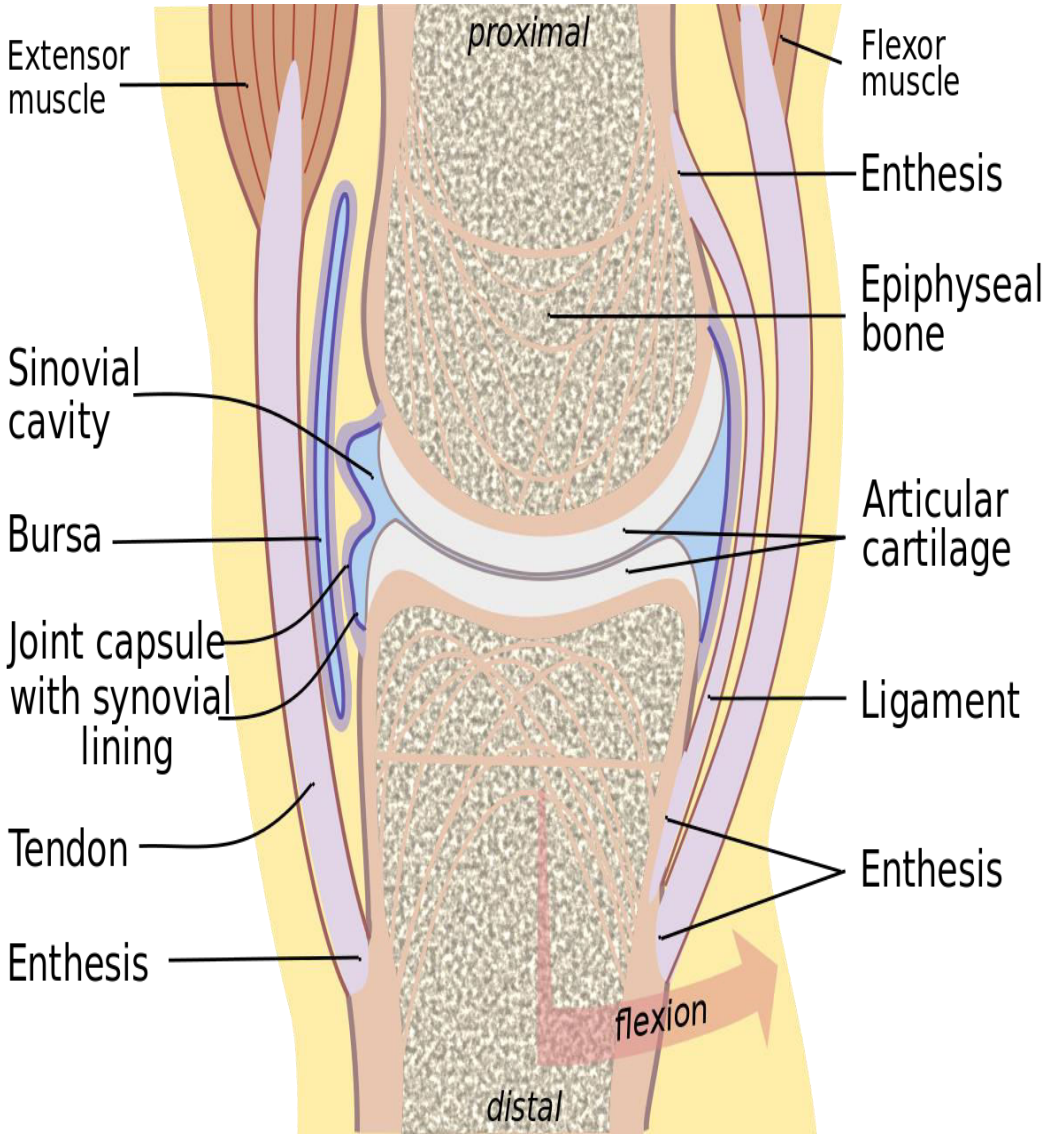
- The cranial bones (8)
  - The occipital bone
  - The parietal bones (2)
  - The frontal bone
  - The temporal bones (2)
  - The sphenoid bone (sometimes counted as facial)
  - The ethmoid bone (sometimes counted as facial)

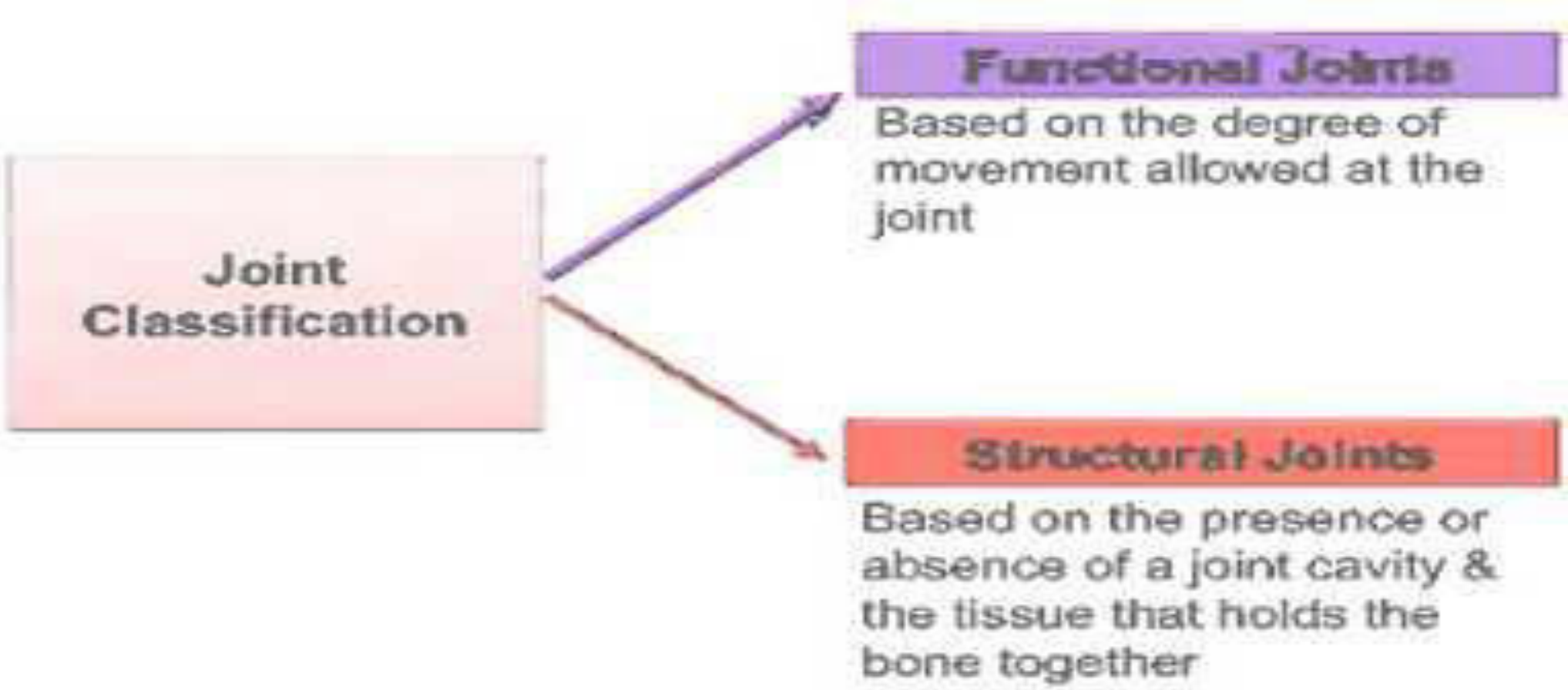


Joints

A **joint** or **articulation** (or **articular surface**) is the connection made between bones in the body which link the skeletal system into a functional whole.

Joints are mainly classified structurally and functionally. Structural classification is determined by how the bones connect to each other, while functional classification is determined by the degree of movement between the articulating bones.



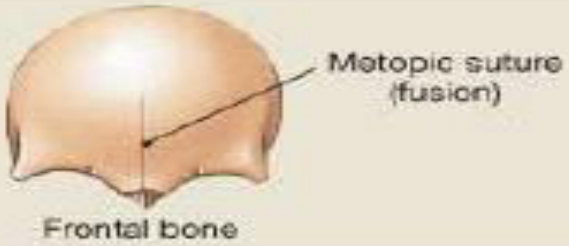

Joint Classification
Functional Joints
Based on the degree of movement allowed at the joint
Structural Joints
Based on the presence or absence of a joint cavity & the tissue that holds the bone together

Structural Classification of Joints

- A fibrous joint occurs where bones are held together by dense regular (fibrous) connective tissue.
- A cartilaginous joint occurs where bones are joined by cartilage.
- A synovial joint
  - has a fluid-filled synovial cavity
  - bones are enclosed within a capsule
  - bones are joined by various ligaments

TABLE 8.2

A Structural Classification of Articulations

Structure	Type	Functional Category	Example*
BONY FUSION	Synostosis	Synarthrosis	 Frontal bone
FIBROUS JOINT	Suture Gomphosis Syndesmosis	Synarthrosis Synarthrosis Amphiarthrosis	 Skull
CARTILAGINOUS JOINT	Synchondrosis Symphysis	Synarthrosis Amphiarthrosis	 Pubic symphysis
SYNOVIAL JOINT	Monaxial Biaxial Triaxial	All diarthroses	 Synovial joint

*For other examples, see Table 8.1

CLASSIFICATION

1. Functional classification

- **Immovable (synarthrosis)**

  Cranial sutures in adult
  Pri cartilaginous jt. in children

- **Slightly movable (amphiarthrosis)**

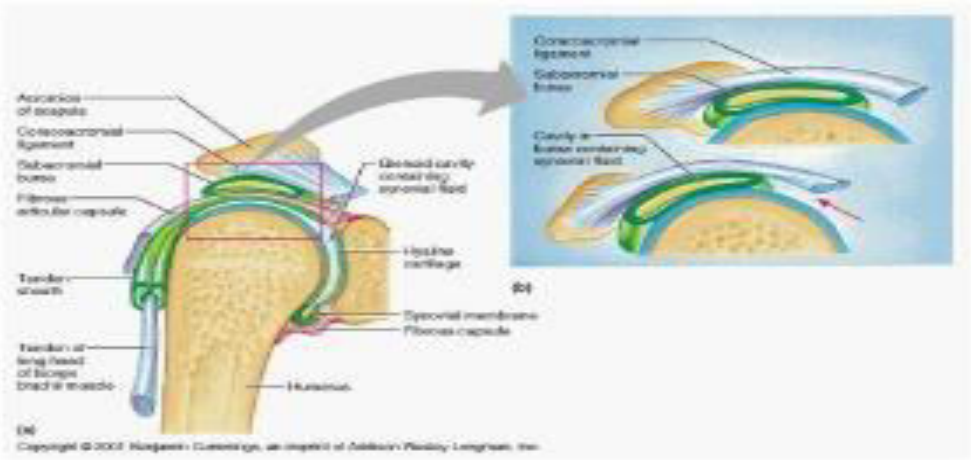
  Secondary cartilaginous jts
  Syndesmosis

- **Freely movable (diarthrosis)**

  Synovial jt.

Classification of Joints

- Functionally
  - Fibrous
    - Dense Regular Connective Tissue
  - Cartilaginous
    - Cartilage
  - Synovial
    - Fluid Filled Joint Cavity
- Structurally
  - Synarthrosis
    - Immobile
  - Amphiarthrosis
    - Slightly Movable Joint
  - Diarthrosis
    - Freely Mobile Joint



Joint Classification

Structural Classification of Joints

- **Fibrous**
  - Suture (S)
  - Syndesmosis (A)
  - Gomphosis (S)
- **Cartilaginous**
  - Synchondrosis (S)
  - Symphysis (A)
- **Synovial (D)**
  - Gliding (N)
  - Hinge (M)
  - Pivot (M)
  - Condyloid (B)
  - Saddle (B)
  - Ball/Socket (P)

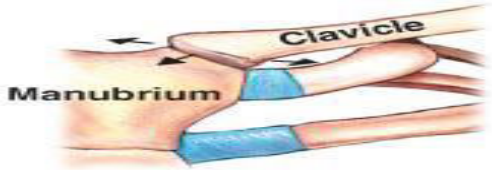
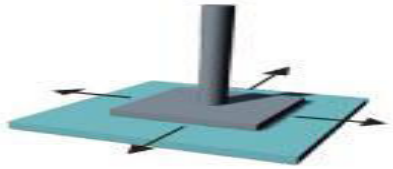
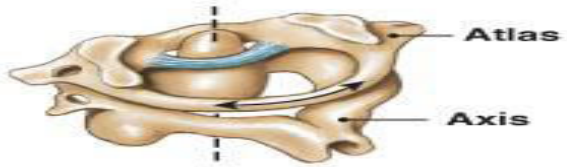
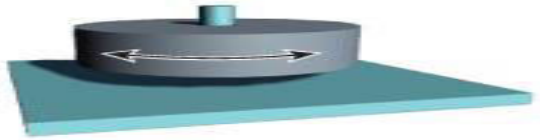
(S) = Synarthrosis (A) = Amphiarthrosis (D) = Diarthrosis	(N) = Nonaxial (M) = Monaxial (B) = Biaxial (P) = Polyaxial

This would be a really good chart to know for the exam!

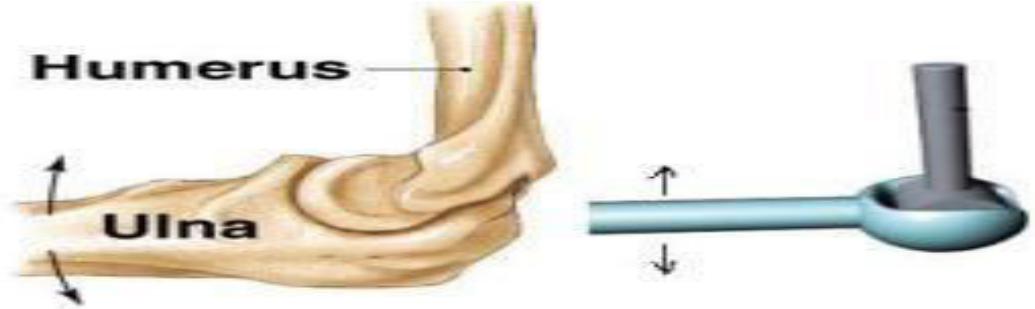
Functional classification (movement)

- synovial joint (also known as a *diarthrosis*) – freely movable.Synovial joints can in turn be classified into six groups according to the type of movement they allow: 1)plane joint, 2)ball and socket joint,3) hinge joint, 4)pivot joint, 5) condyloid joint and 6) saddle joint.

The anatomical types of synovial joints, with joint models and examples

Types of Synovial Joints	Models of Joint Motion	Examples
Gliding joint 		• Acromioclavicular and sternoclavicular joints • Intercarpal and intertarsal joints • Vertebrocostal joints • Sacro-iliac joints
Hinge joint 		• Elbow joints • Knee joints • Ankle joints • Interphalangeal joints
Pivot joint 		• Atlas/axis • Proximal radio-ulnar joints
Ellipsoid joint 		• Radiocarpal joints • Metacarpophalangeal joints 2–5 • Metatarsophalangeal joints
Saddle joint 		• First carpometacarpal joints
Ball-and-socket joint 		• Shoulder joints • Hip joints

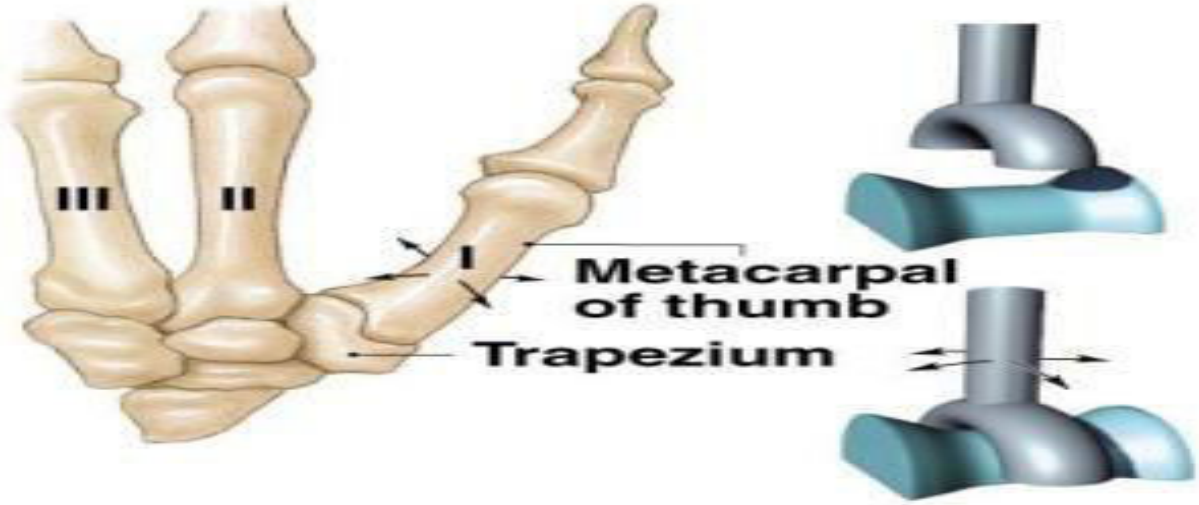
(a) Gliding joint



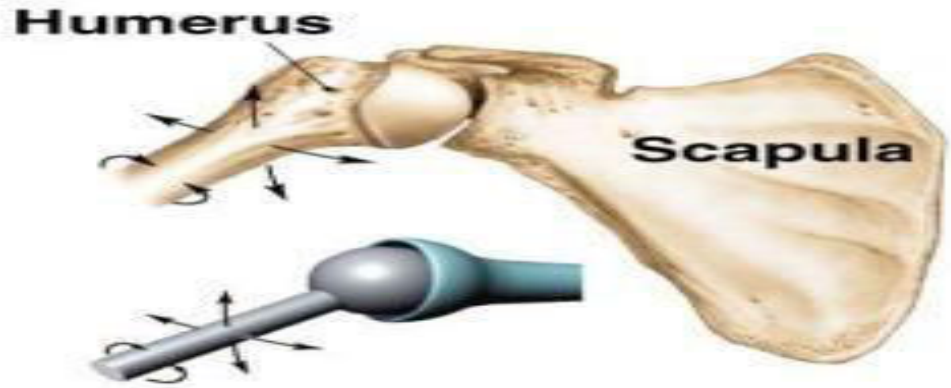
(b) Hinge joint

(c) Pivot joint

(d) Ellipsoidal joint



(e) Saddle joint



(f) Ball-and-socket joint

Muscular System

- Locomotion and bodily movements are characteristic features of the animals.
- Muscular movements are more powerful and energetic.
- The skeletal muscles apart from their role in smarter movements, provide beautiful shapes to the body.
- The inner smooth muscles of the visceral organs make them work like machines all through the life period.
- The muscle cells function like small motors to produce the forces responsible for the movement of the arms, legs, heart and other part of the body.
- Thus the highly specialized muscle tissues are responsible for

Based on structure, functioning and occurrence **three different types of muscle tissues.** They are the skeletal, visceral (smooth) and cardiac muscles

1). Skeletal muscles or striped muscles :These muscles are attached to the bones. The muscle cells are long and cylindrical. These voluntary muscles cause body movements.

2). Visceral muscles or Nonstriated muscles or smooth muscles :These are found in the walls of the inner organs such as blood vessels, stomach and intestine. The muscle cells are spindle shaped. These are involuntary in nature.

3). Cardiac muscle :These are found in the wall of the heart. The muscle cells are cylindrical and branched. The muscles are involuntary in nature.

Skeletal muscles

The skeletal muscles are attached to bones by tendons. The tendons help to transfer the forces developed by skeletal muscles to the bones. These muscles are covered by sheets of connective tissue called fascia.

Tendons : These are connective tissue structures showing slight elasticity. They are like cords or straps strongly attached to bones. The tensile strength of tendons is nearly half that of steel. A tendon having 10 mm diameter can support 600 - 1000 kg.

Fascia : These are assemblages of connective tissues lining skeletal muscles as membranous sheets. The fascia may be superficial or deep. The superficial fascia is a layer of loose connective tissue found in between skin and muscles.

The deep fascia are collagen fibres found as a tough inelastic sheath around the musculature. They run between groups of muscles and connect with the

Naming of muscles. The muscles are named according to their size, shape, position and action.

Shape

- deltoid - triangle
- quadratus – square
- gracilis – slender

Number of Heads

- biceps - 2 heads
- triceps - 3 heads
- Quandriceps - 4 heads

Depth

- superficialis – superficial
- internus - internal, flexor
- profundus - deep

Size

- major -large
- minor –small
- longus –long
- lattismus - broadest

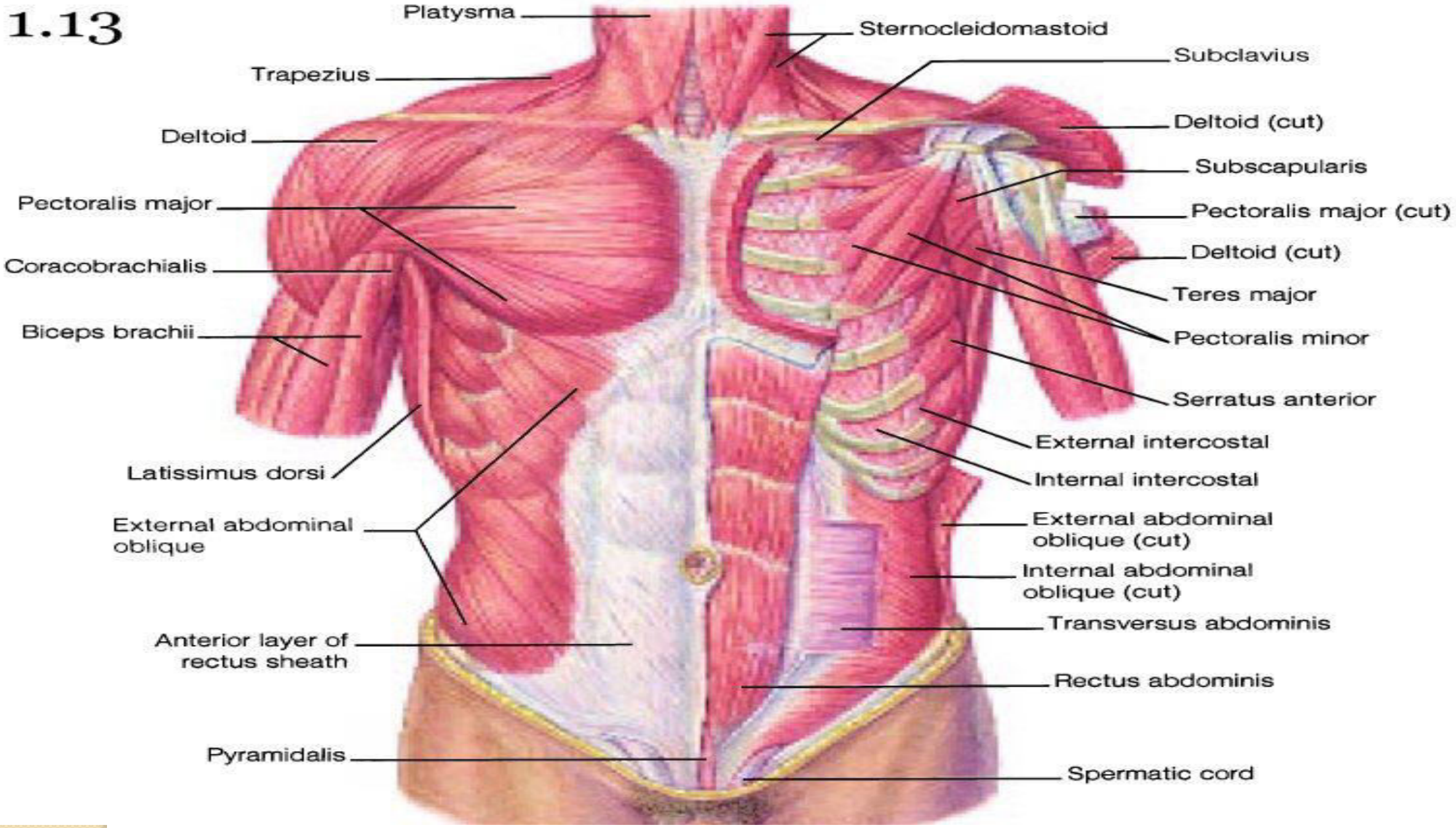
Position

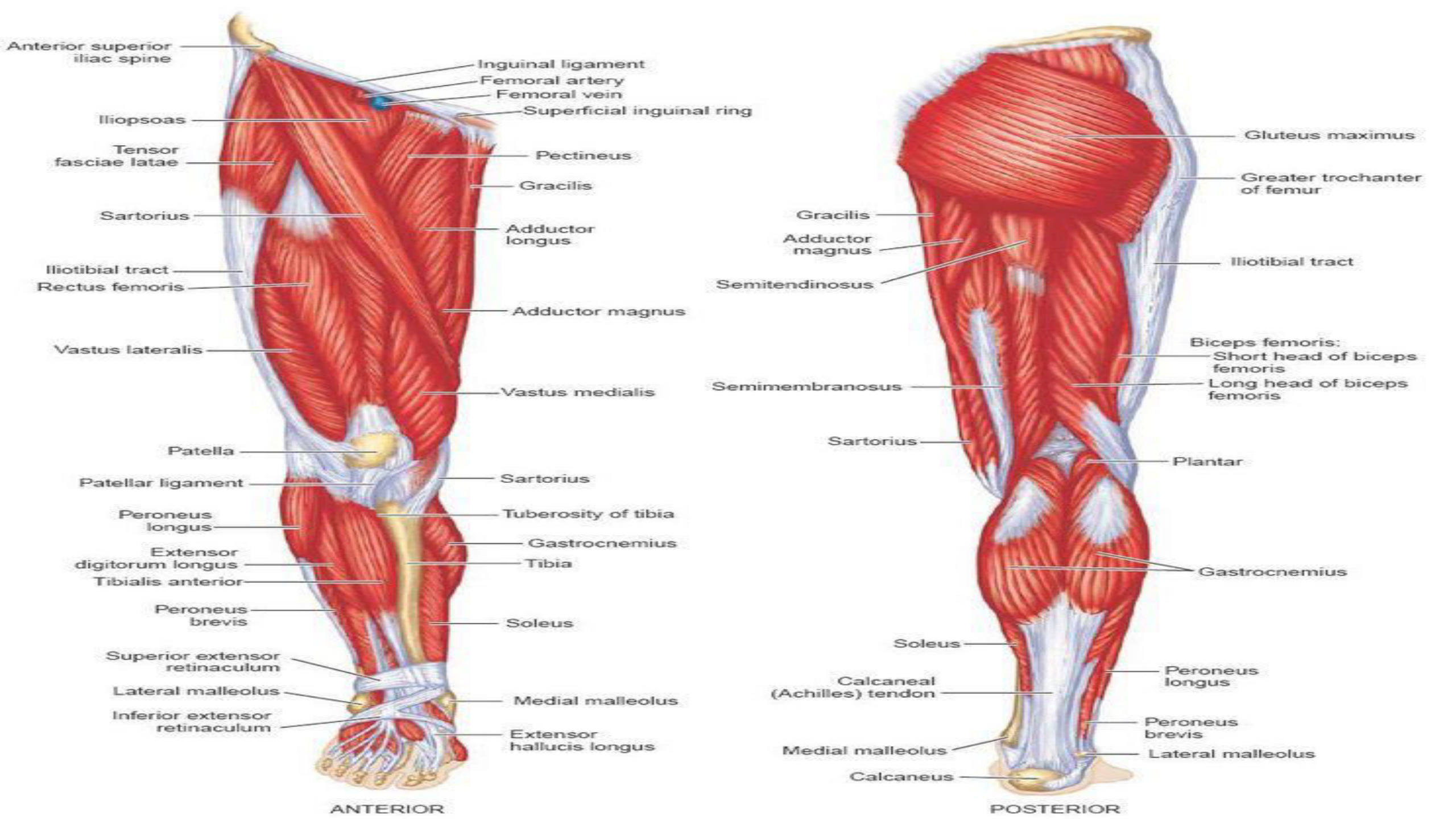
- dorsi - of the back
- pectoralis - of the chest
- brachii - of the arm anterior, posterior.

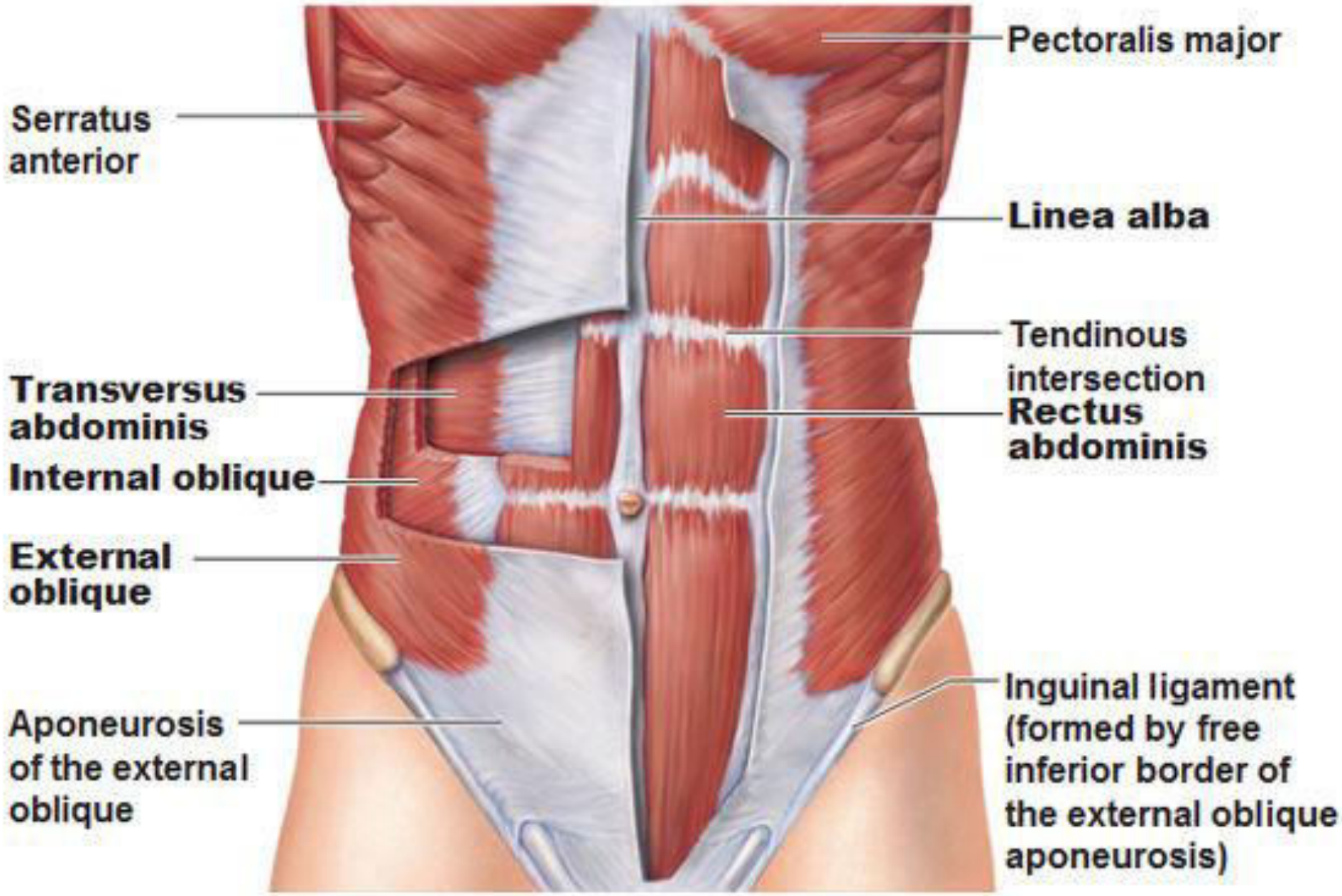
Action

- extensor
- constrictor
- Flexor

1.13


Platysma
Sternocleidomastoid
Subclavius
Trapezius
Deltoid
Deltoid (cut)
Subscapularis
Pectoralis major
Pectoralis major (cut)
Coracobrachialis
Deltoid (cut)
Teres major
Biceps brachii
Pectoralis minor
Serratus anterior
External intercostal
Latissimus dorsi
Internal intercostal
External abdominal oblique
External abdominal oblique (cut)
Internal abdominal oblique (cut)
Transversus abdominis
Anterior layer of rectus sheath
Rectus abdominis
Pyramidalis
Spermatic cord


Anterior superior iliac spine
Inguinal ligament
Femoral artery
Femoral vein
Superficial inguinal ring
Iliopsoas
Tensor fasciae latae
Pectineus
Gracilis
Sartorius
Adductor longus
Iliotibial tract
Rectus femoris
Adductor magnus
Vastus lateralis
Vastus medialis
Patella
Patellar ligament
Sartorius
Peroneus longus
Tuberosity of tibia
Gastrocnemius
Extensor digitorum longus
Tibialis anterior
Tibia
Peroneus brevis
Soleus
Superior extensor retinaculum
Lateral malleolus
Medial malleolus
Inferior extensor retinaculum
Extensor hallucis longus
ANTERIOR
Gluteus maximus
Greater trochanter of femur
Gracilis
Adductor magnus
Iliotibial tract
Semitendinosus
Biceps femoris:
Short head of biceps femoris
Long head of biceps femoris
Semimembranosus
Sartorius
Plantar
Gastrocnemius
Soleus
Peroneus longus
Calcaneal (Achilles) tendon
Peroneus brevis
Medial malleolus
Lateral malleolus
Calcaneus
POSTERIOR


Pectoralis major
Serratus anterior
Linea alba
Tendinous intersection
Transversus abdominis
Rectus abdominis
Internal oblique
External oblique
Aponeurosis of the external oblique
Inguinal ligament (formed by free inferior border of the external oblique aponeurosis)

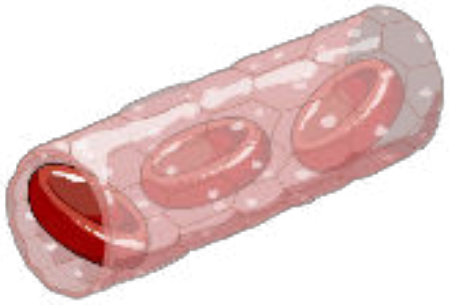
The Circulatory System

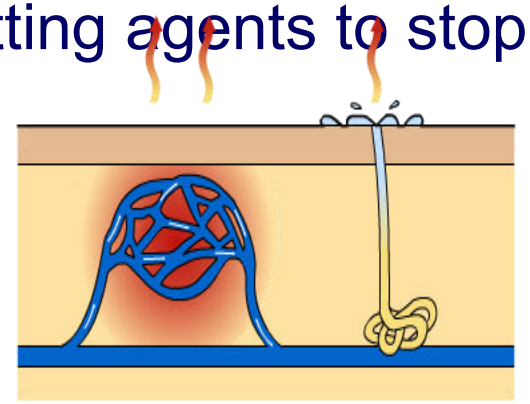
- The circulatory system has three functions:

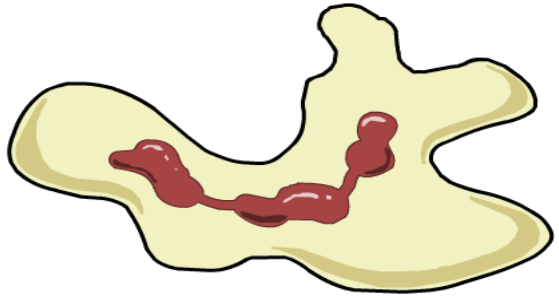
1. **Transporting** substances around the body. These include oxygen, glucose, carbon dioxide, nutrients, water and waste products

2. **Controlling** body temperature.

3. **Protecting** the body. Blood contains cells and anti-bodies that fight infection and clotting agents to stop bleeding.







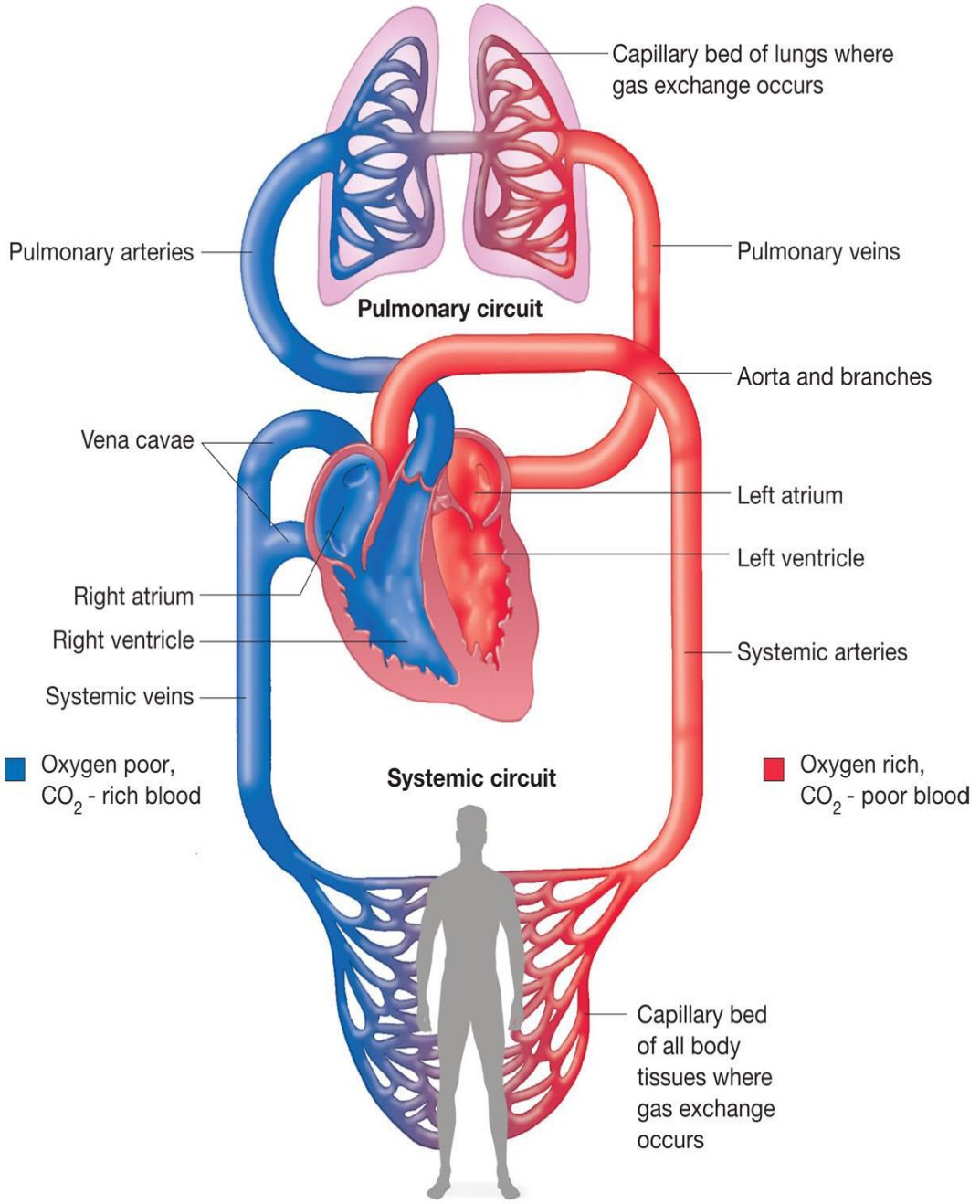
The double circulatory system

The **pulmonary circulation** carries:

- deoxygenated blood from the heart to the lungs
- oxygenated blood back from the lungs to the heart, ready to be pumped out to the body

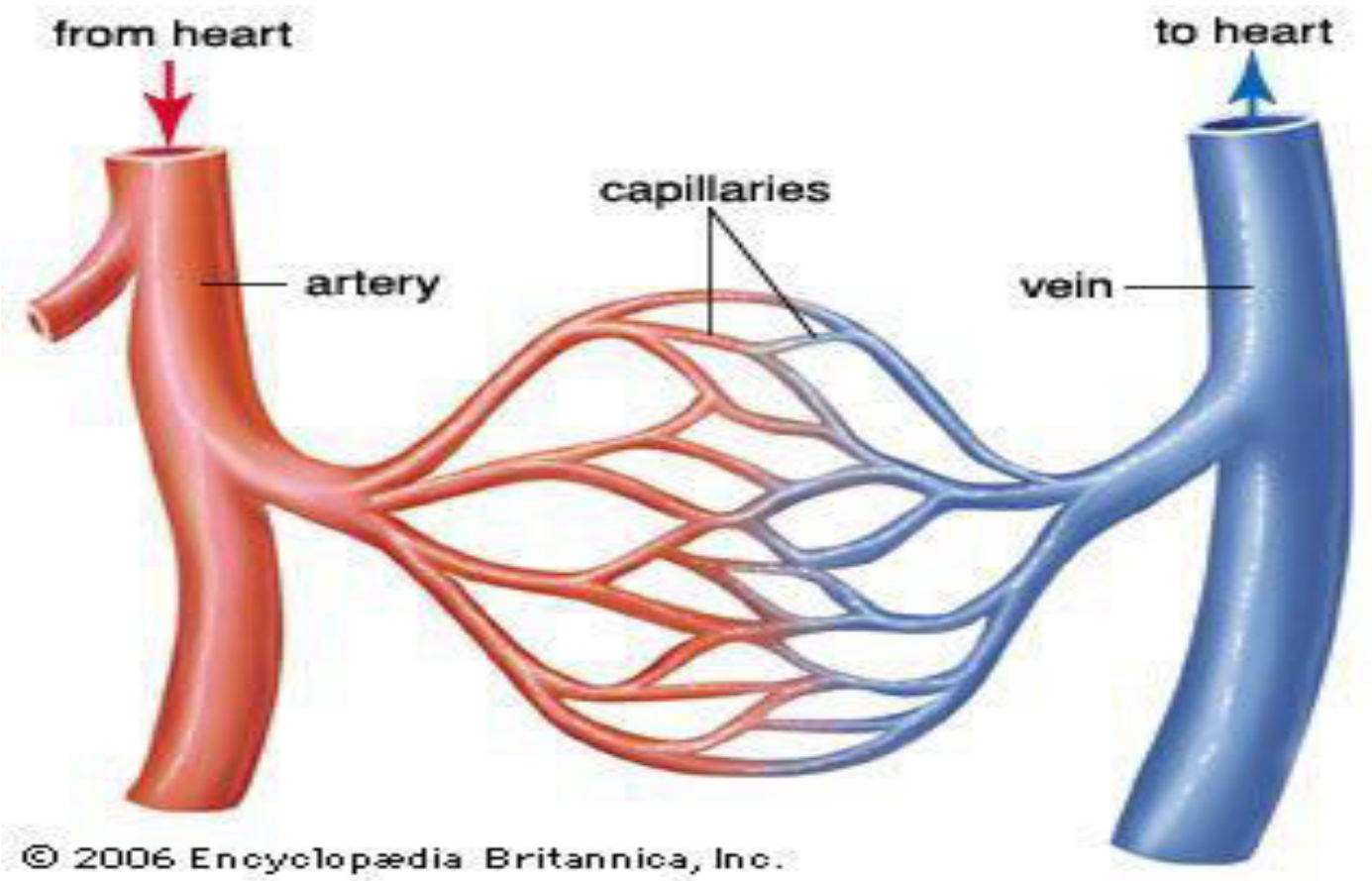
The **systemic circulation** carries:

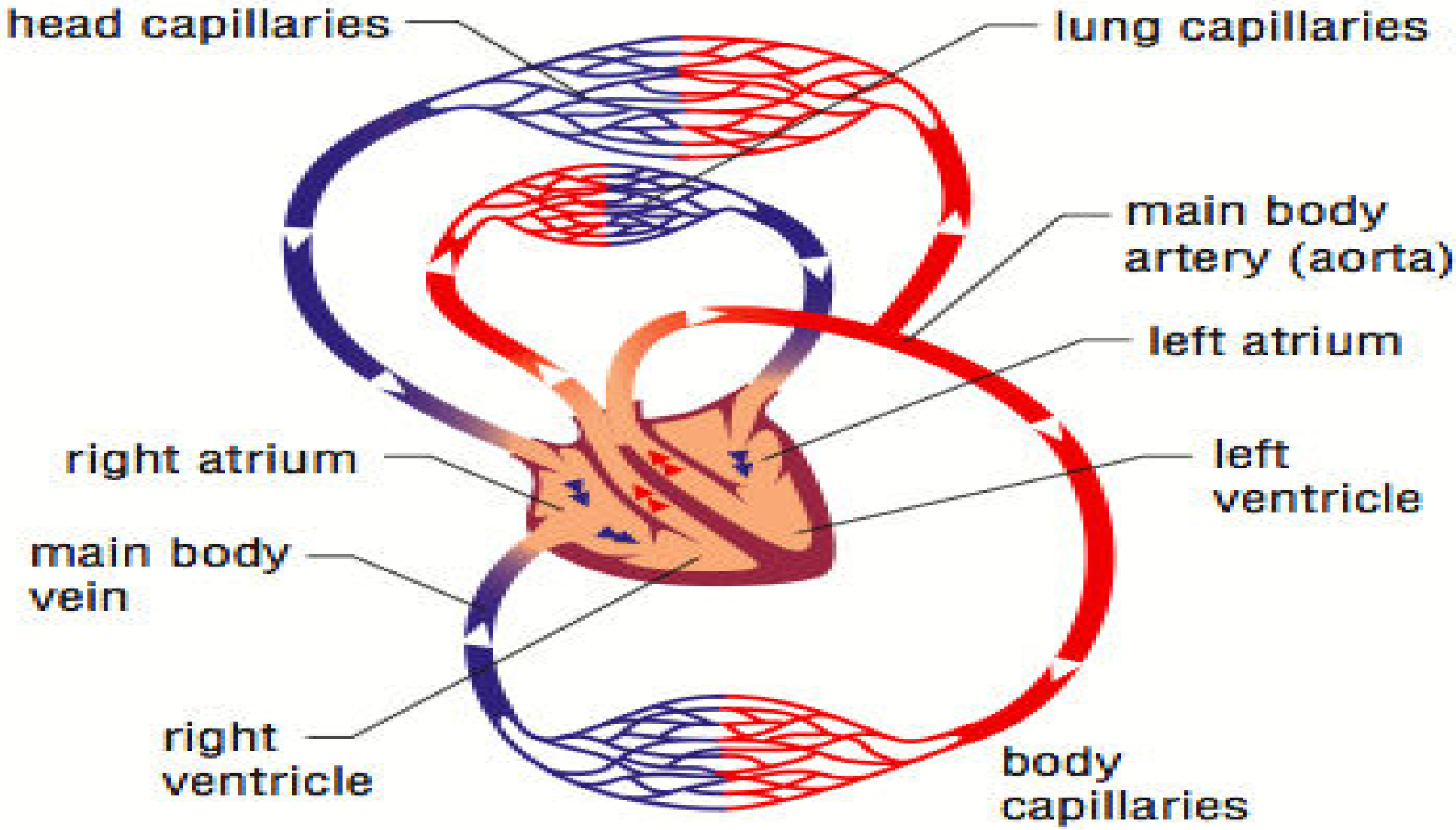
- oxygenated blood to the rest of the body through the arteries
- deoxygenated blood back to the heart through the veins.



Blood vessels

There are **three types** of **blood vessels**, as shown in this magnified part of the circulatory system.





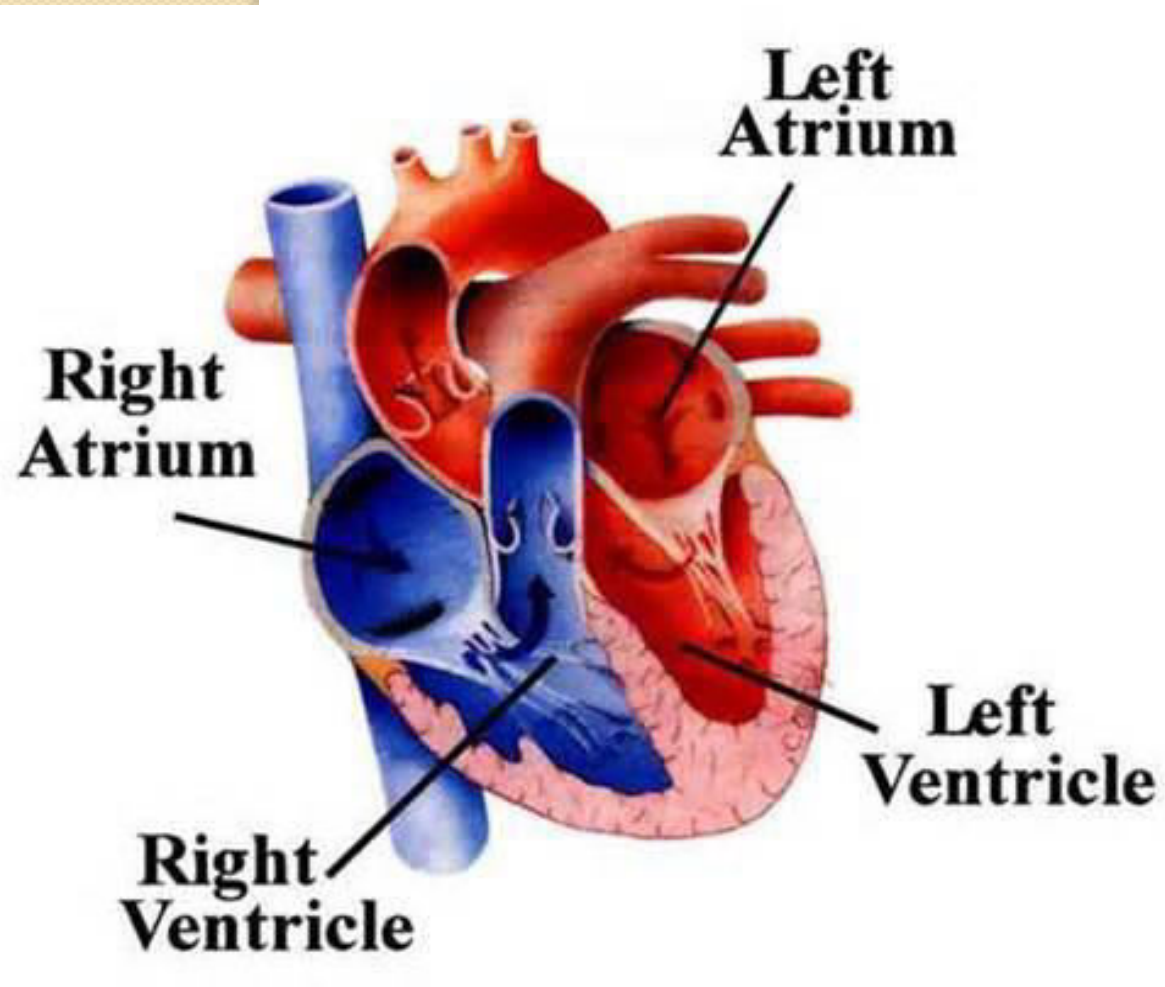
The human circulatory system is a network of arteries, veins and capillaries

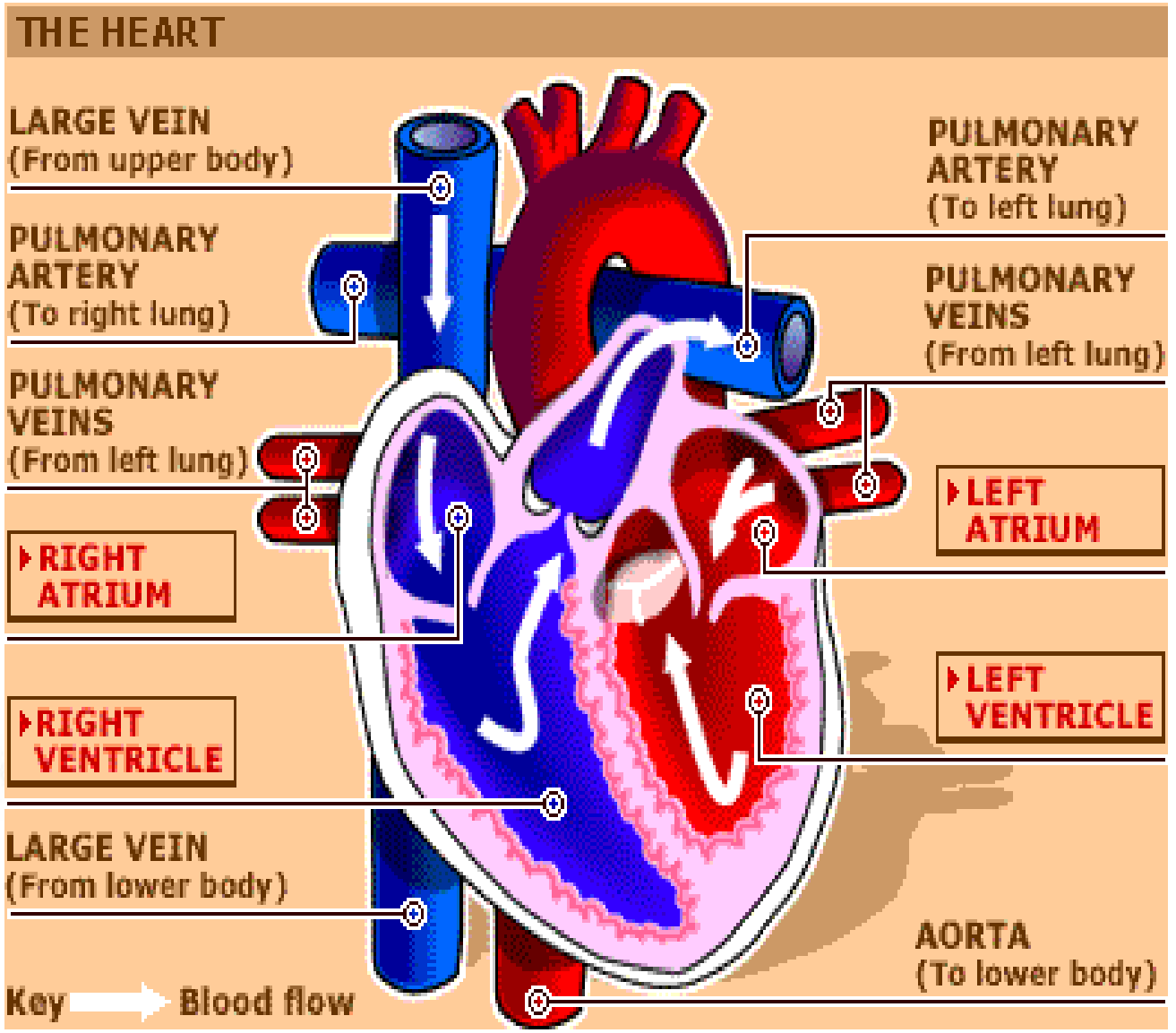
Fig 4.3.2

Arteries	**Veins**	**Capillaries**
From heart to rest of body	From rest of body to heart	Connects arteries and veins
Carries mostly oxygenated blood	Carries mostly deoxygenated blood	Carries both [de]oxygenated blood
High pressure with thicker walls	Low pressure with thinner walls	Walls only one-cell thick for diffusion
No valves	Has valves	No valves
Blood speed fast	Blood speed slow	

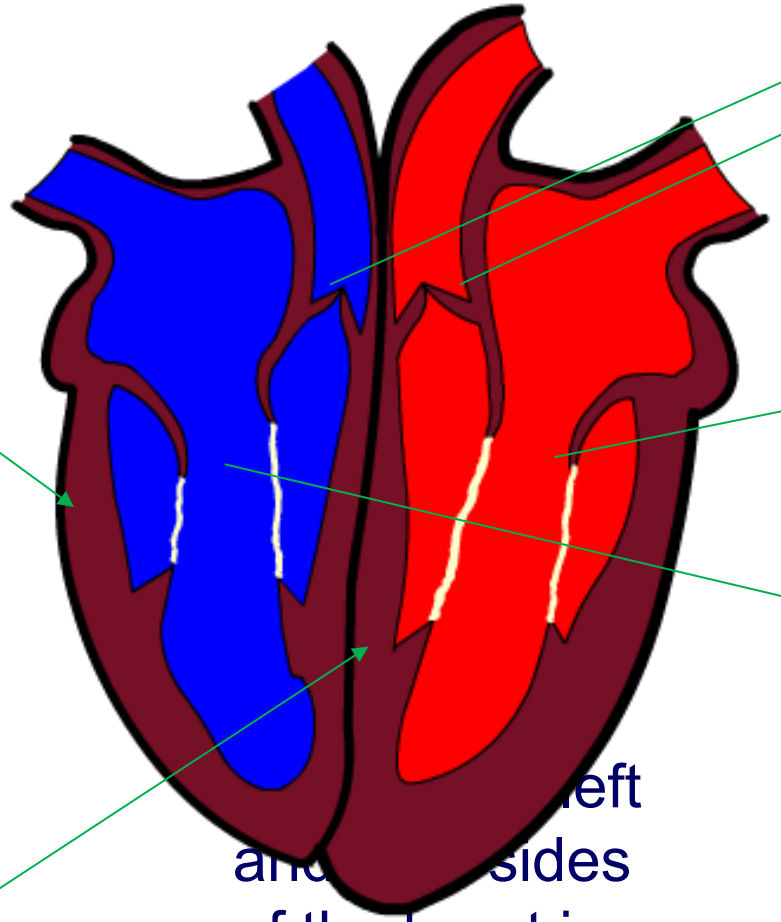
Cardiac system

The four chambers of the heart have special names





The walls are made of **cardiac muscle**



The **semi-lunar valves** prevent expelled blood flowing back into the heart.

Bicuspid(mitral) valve

Tricuspidvalve

These two **valves**prevent blood flowing back into the atria from the ventricles

eft
ides
of the heart is called the **septum**.

The heart during exercise

Heart rate (or **pulse rate**) is the number of times your heart beats every minute.
It is expressed in **beats per minute** (bpm).

- Resting heart rate varies from individual to individual and is affected by fitness.
  The fitter you are, the lower your resting heart rate will be.
- The average resting heart rate is about 70–75 bpm.

The pulse rate is not the only way of measuring the heart.

Cardiac output is the amount of blood pumped out of the left ventricle of the heart per minute.

Stroke volume is the amount of blood pumped out of the left

cardiac output = stroke volume × heart rate

- The heart gets larger
- •The muscular wall become thicker and stronger
- •Stroke volume at rest increases, leading to a lower resting heart rate.

The Circulatory System

The multicellular organisation in animal world has resulted in the origin and evolution of circulatary system in animals. This arrangement facilitates internal transport of various substances to all organs and organ systems. Among majority of multicellular animals this system remains as a closed type. It has blood running inside closed blood vessels, the blood being pumped by heart. In man, as in all mammals there is a double circulation of blood. The primary circulation through pumping action of heart, supplies blood to all regions of the body. The blood later returns to the heart. It is called the systemic circulation or body circulation. A similar circulation carries blood to lungs for oxygenation and returns it back to the heart. It is called the pulmonary circulation.

Systemic and Pulmonary circulations The most important component of this system is the heart. It is a large, muscular, valved structure having four chambers. The chambers are the right atrium, left atrium, right ventricle and left ventricle. Each atrium opens into a corresponding ventricle. The right and left chambers are separated by septa.

Systemic circulation :- The left atrium receives oxygenated blood from the lungs, through the pulmonary vein. When the atria contract, blood from the left atrium is forced into the left ventricle. Later by a contraction of the ventricle, the blood leaves the heart through the aorta. The aorta is the single systemic artery emerging from the heart. By successive branchings, the aorta

gives rise to hundreds of arteries taking blood to all regions of the body. As the branchings happen, the arteries divide into numerous (4 × 106) arterioles. In the target organs they produce four times as many capillaries. A similar number of venules converge into each other forming veins of increasingly larger size. Finally, only two veins, the superior and inferior vena cavae return the blood to the right atrium. Thus the course of blood from left ventricles through the body organs and back to the atrium forms the systemic circulation. Pulmonary circulation :- The venous blood from right atrium is conducted to the right ventricle. The ventricle expels the blood via the pulmonary trunk to the lungs. The oxygenated blood later returns by the pulmonary veins to the left atrium. This circulation from right ventricle to the left atrium via the lungs is termed the pulmonary circulation.

Pulmonary circulation :- The venous blood from right atrium is conducted to the right ventricle. The ventricle expels the blood via the pulmonary trunk to the lungs. The oxygenated blood later returns by the pulmonary veins to the left atrium. This circulation from right ventricle to the left atrium via the lungs is termed the pulmonary circulation.

The Heart

The heart is a hollow, fibromuscular organ. It is somewhat conical or pyramidal in form. It is roughly the size of a closed fist. An average heart measures 12 cm from base to the apex. Transverse diameter at its broadest region is 8-9 cm. It is 6 cm thick antero-posteriorly. While in adult male the heart weighs 280-340 g, in female it weighs 230-280 g.

The thoracic organs such as heart, trachea and oesophagus form a midline partition called the mediastinum. The heart lies obliquely in the mediastinum. The heart is surrounded by a double layered membrane called the pericardium. The outer layer is called the fibrous pericardium. The inner membrane is called the serous pericardium. In between heart and pericardium, there is a pericardial space. This space is filled with a fluid called the pericardial fluid.

The wall of the heart is made up of three tissue layers. They are the epicardium, myocardium and endocardium. The epicardium forms the smooth outer surface of the heart. The middle myocardium is composed of cardiac muscle. This layer plays an important role in the functioning of the heart. The endocardium forms the smooth inner surface. It is formed of squamous epithelium.

Digestive system

Phases of Digestion

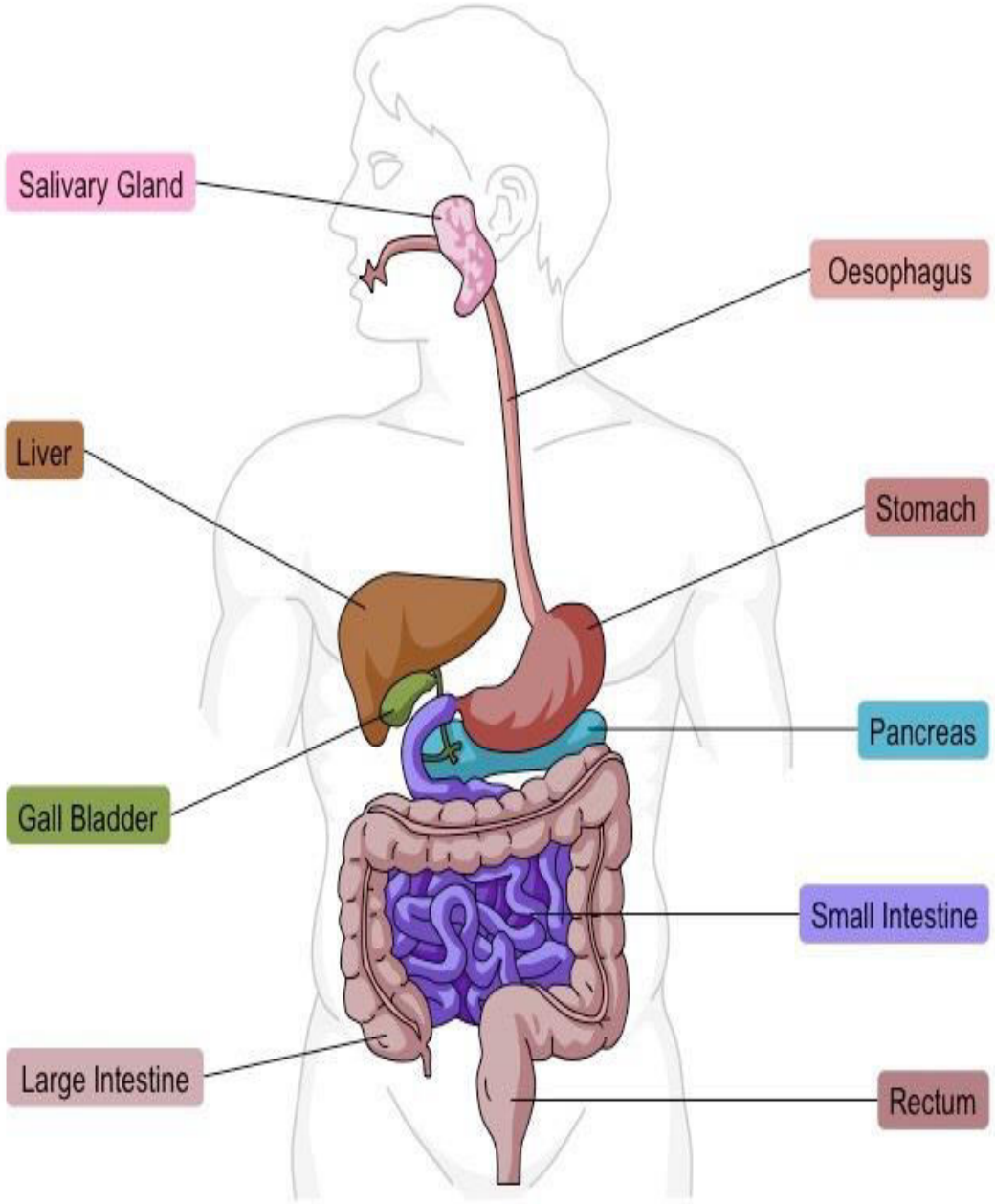
- Ingestion
- Movement
- Mechanical and Chemical Digestion
- Absorption
- Elimination

Organs of digestive system

1. Mouth •
2. Pharynx •
3. Esophagus •
4. Stomach •
5. Small intestine •
6. Large Intestine •
7. Rectum

Mouth

- Teeth mechanically break down food into small pieces.
- Tongue mixes food with saliva (contains amylase, which helps break down starch).
- Epiglottis: flaplike structure at the back of the throat.
- Closes over the trachea preventing food from entering it. It is locatedin the Pharynx .



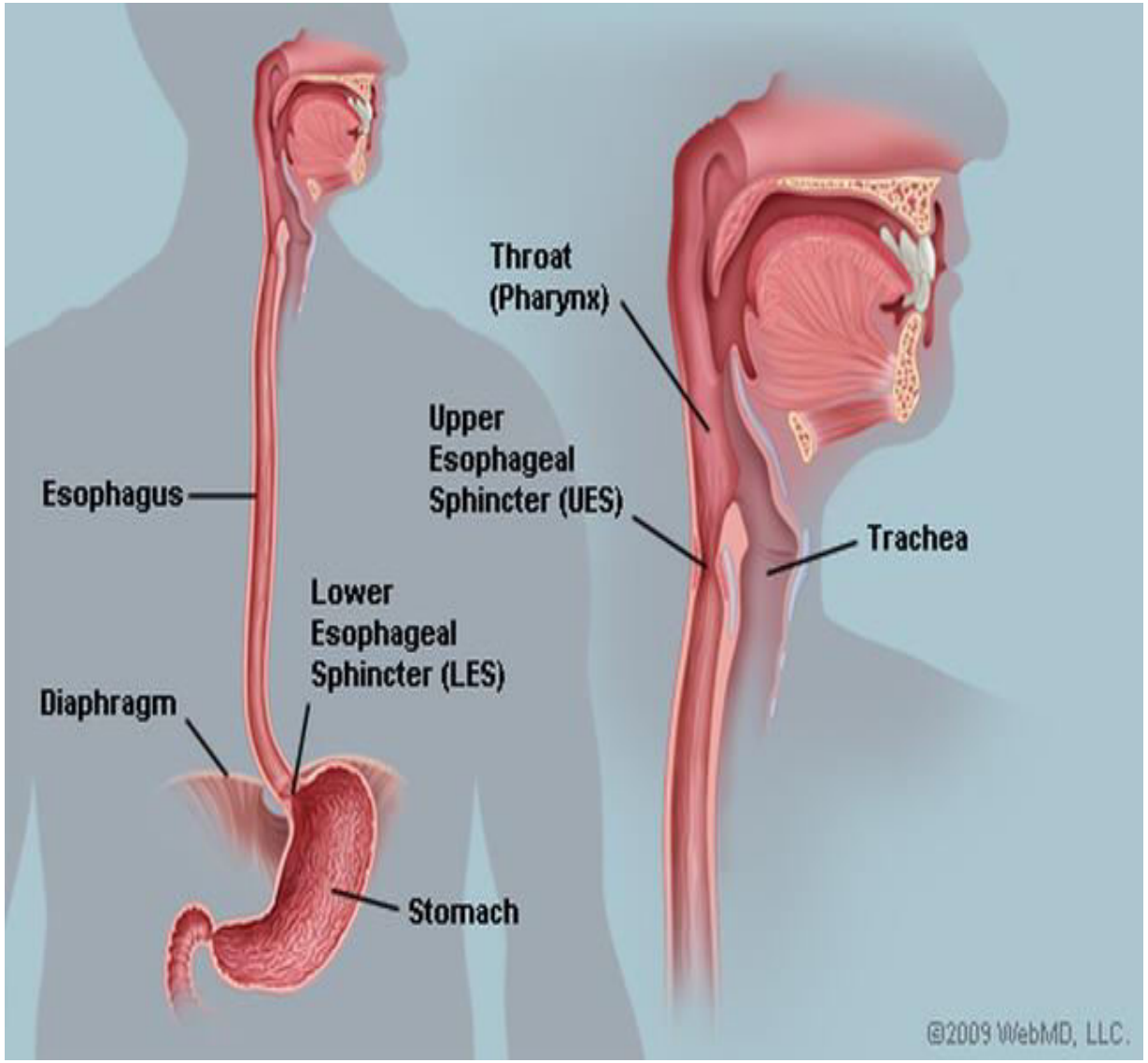
Esophagus

• Approximately 20 cm long .

Functions include: mucus Secreting and moving food from the throat to the stomach using muscle movement called peristalsis

Pharynx :

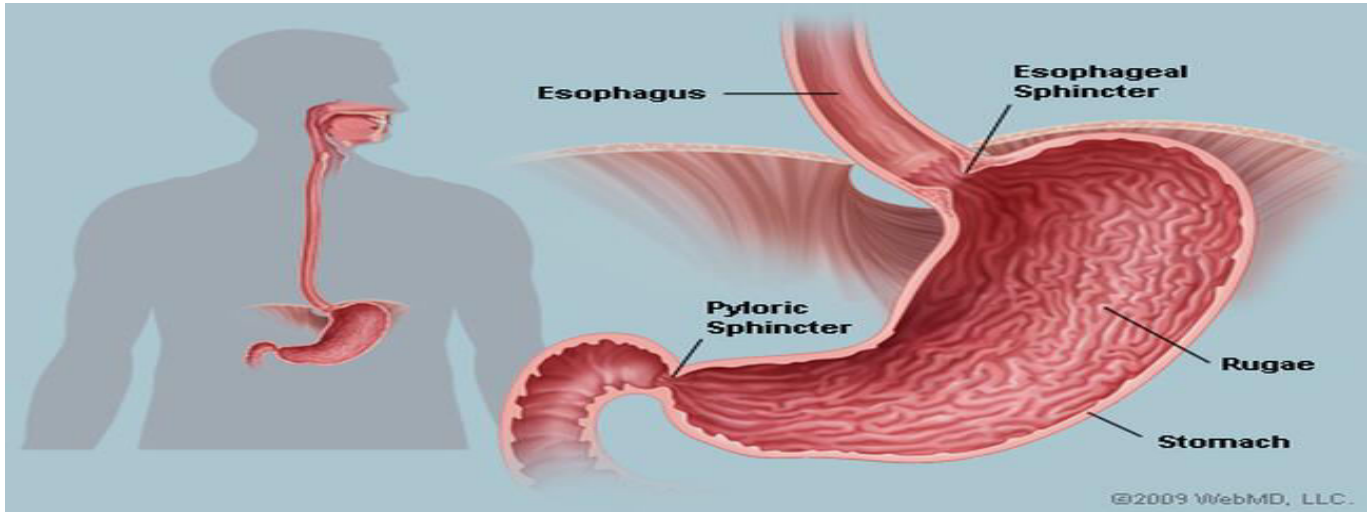
A description of pharynx is provided under respiratory system.



Stomach

• Jshaped muscular bag that stores the food and breaks it down into tiny pieces.

- Mixes food with gastric juices enzymes to break downcontain proteins and lipids .
- Hydrochloric acid in the stomach kills bacteria.
- Food found in the stomach is called chyme



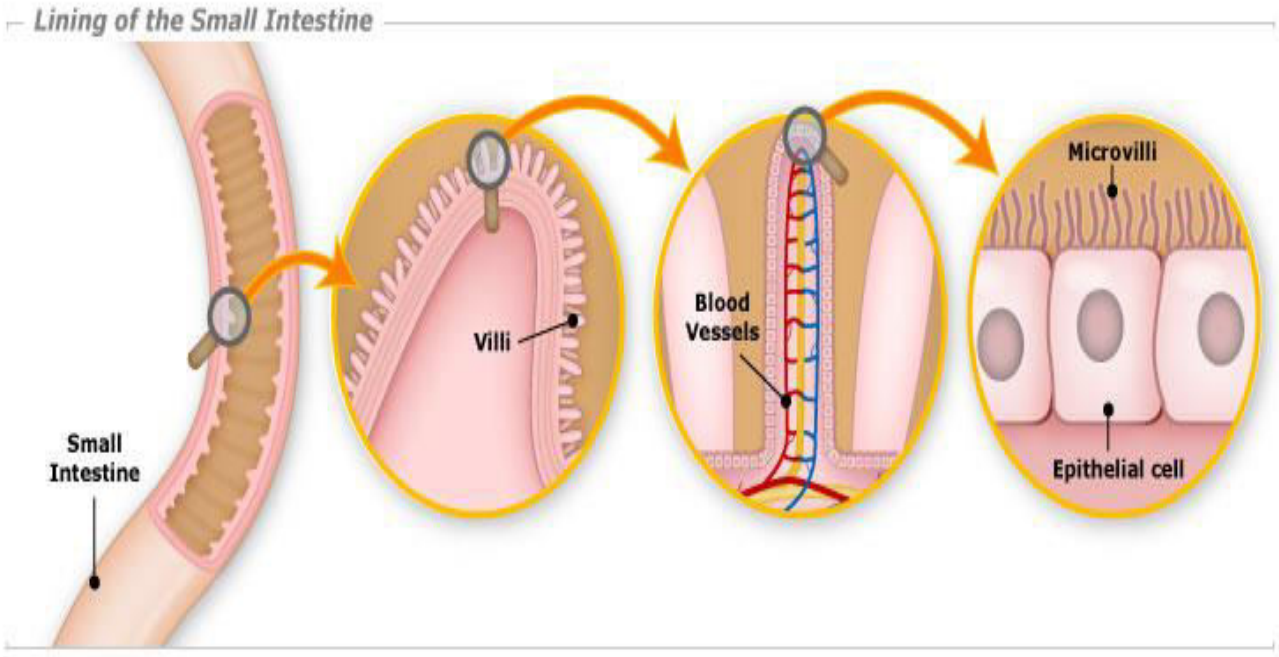
Small Intestine

- Small intestines are roughly Lining of intestine walls has 7 meters fingerlong
- Walls of the intestine like projections called villi, to increase surface area.
- The villi are covered in microvilli which further increases surface area for absorption.

Nutrients from the food pass into the bloodstream through the walls of the small intestine.

Absorbs:

1. 80% ingested water
2. Vitamins
3. Minerals
4. Carbohydrates
5. Proteins
6. Lipids
7. Secretes digestive enzy

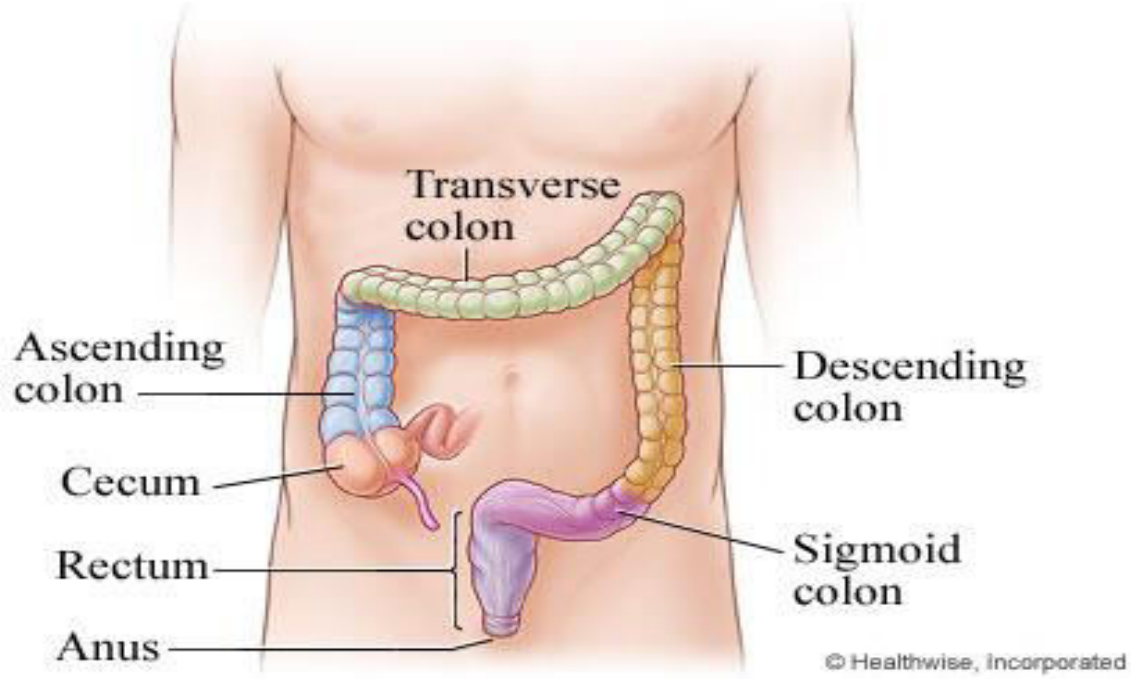


Large Intestine

About 1.5 meters long Absorbs nutrients left behind by the small intestines. The end of the large intestine is the rectum. (short term storage which holds feces before it is expelled).

Functions

- Bacterial digestion and fermentation of carbohydrates
- Absorbs additional water
- Concentrates wastes

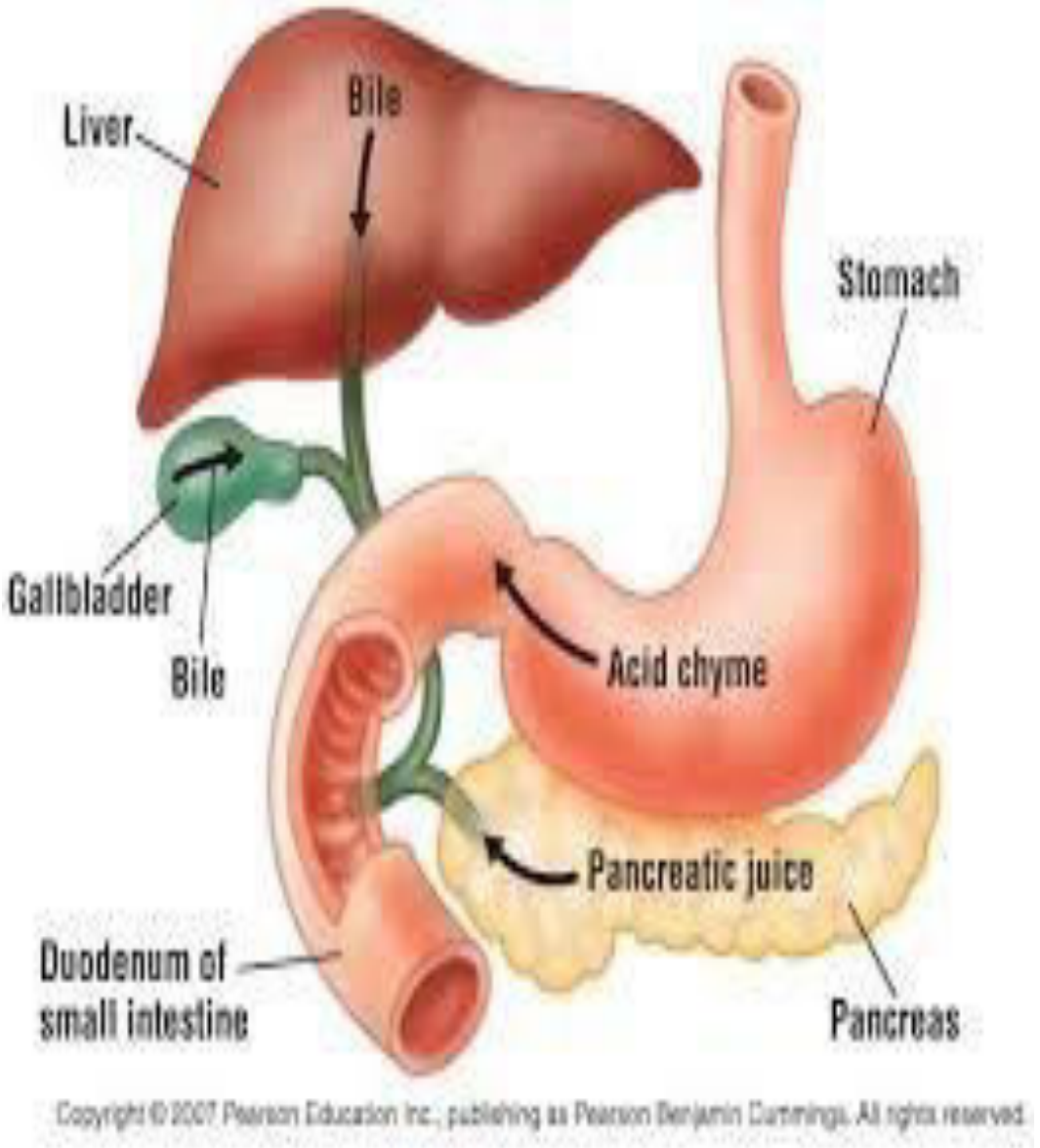


Accessory Organs The Glands

- Not part of the path of ingested food , but play a critical role in digestion.
- Includes: Liver, gall bladder, and pancreas

Liver

- Directly affects digestion by producing bile
- Bile aids in the digestion of fat
- Filters out digestion of fat toxins and waste including drugs, alcohol and poisons.



Gall Bladder

Stores bile from the liver, releases it into the small intestine.

Fatty diets can cause the formation of gallstones

Pancreas

Produces digestive enzymes to digest fats, carbohydrates and proteins

Regulates blood sugar by producing insulin

Respiratory system

The process of respiration involves movement of air in and out of the lungs, gas exchange between air in lungs and the blood, transport of O_2 and CO_2.

These processes are facilitated by working together of well developed respiratory organs and the circulatory system. The respiratory organs include

nasal cavity, pharynx, larynx, trachea, bronchi and lungs.

These organs are organised into upper and lower respiratory tracts.

1. Nasal cavity : The nasal cavity follows the external nose. The nose is a visible prominent structure. Internally it is supported by cartilage plates. The bridge of the nose is formed of the nasal bones and extension of the skullbones(frontal and maxillary). The respiratary passage is divided into two chambers by a median partition. The nasal passage opens to the outside through external nostrils. It opens inside by internal nostrils at the pharynx.
2. Pharynx : The buccal cavity and the nasal passage open into the pharynx. It is a common pathway that opens into the oesophagus of the alimentary canal and larynx of the respiratory system. The pharynx is divided into three regions, namely the nasopharynx, the oropharynx and the laryngopharynx.

3. Larynx : The larynx is seen just behind the pharynx and the buccal cavity. This region is surrounded by cartilages(3 unpaired and 6 paired). These are interconnected by muscles and ligaments.

4. Trachea (or wind pipe) : It is a membranous tube. The wall is made up of connective tissue and smooth muscles. The wall is provided support by 15-20 'C' shaped cartilage rings. They protect the trachea and keep it open all the time.

5. Lungs : The pair of lungs are the actual organs of respiration. Each lung is conical in shape. The base of the lung rests on the diaphragm. The right lung is larger than the left and it weighs around 620g. The left lung weighs 560g. The right lung has three lobes and the left lung has two.

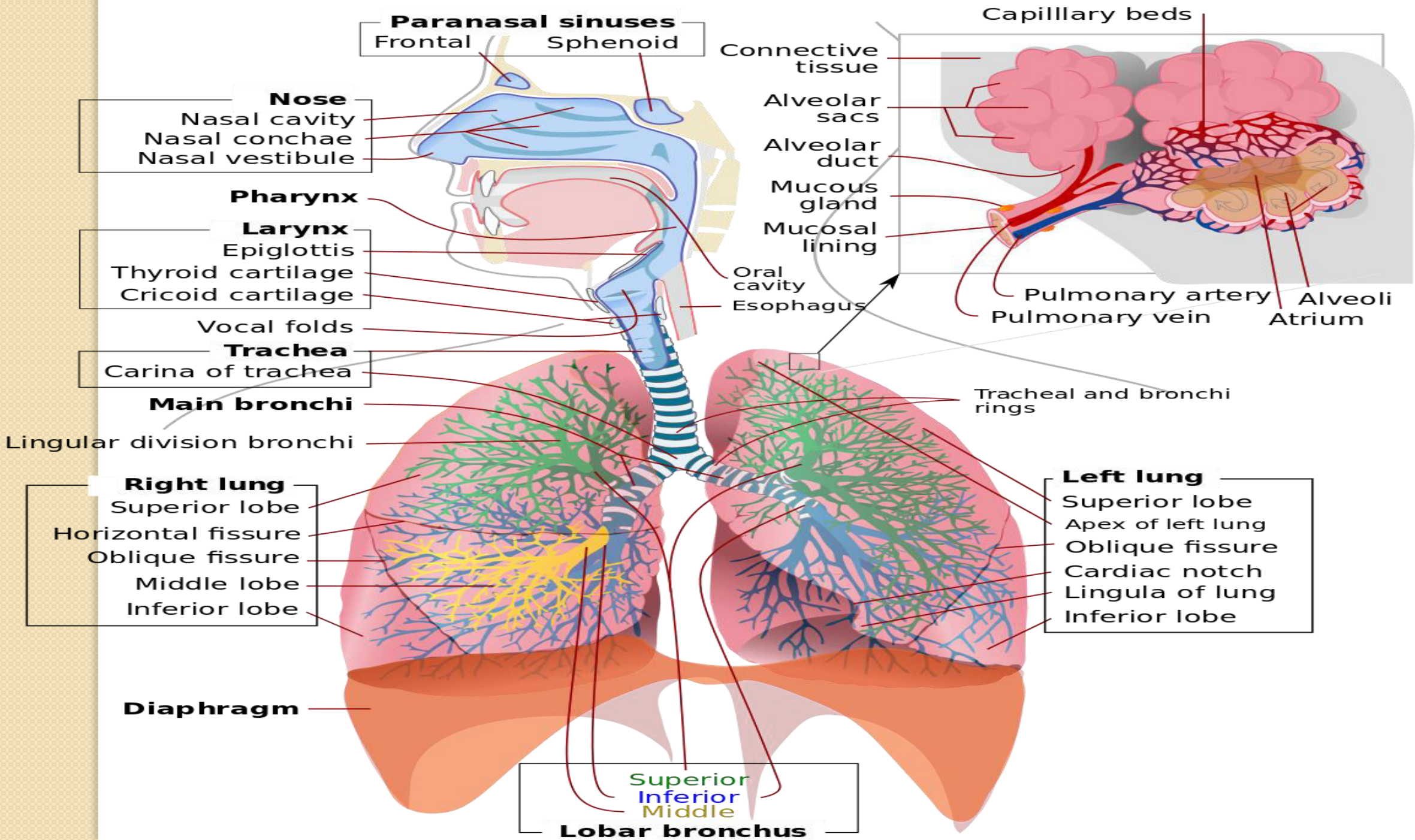
The lungs are placed within the thoracic cavity. Each lung is surrounded by separate pleural membrane. The region inside the pleural membrane is named as the pleural cavity. This cavity is filled with pleural fluid.

The primary bronchi on entering into each lung divide further into secondary bronchi. There are two secondary bronchi in the left lung and three in the right lung. The secondary bronchi inturn give rise to tertiary bronchi.

They divide still further and finally give rise to bronchioles. The diameter of the bronchioles is less than 1 mm. These bronchioles divide several times to become still smaller terminal bronchioles.

Like the trachea, the primary bronchi are supported by 'C'. shaped cartilages and smooth muscles. As the bronchi become smaller the cartilages are replaced by smooth muscles. The terminal branchioles end in small air filled chambers called alveoli. The alveoli are thin walled pouches.

They collectivelly provide the respiratory surface for gaseous exchange. The wall of the alveolus is very thin providing a minimal barrier to gaseous exchange between air and blood. The thickness of the wall of the alveolus is as little as 0.05m. Studies have shown that in human lungs there are about 300 million alveoli. They provide a mean total alveolar surface area value of 143 m2.


Paranasal sinuses
Frontal
Sphenoid
Nose
Nasal cavity
Nasal conchae
Nasal vestibule
Pharynx
Larynx
Epiglottis
Thyroid cartilage
Cricoid cartilage
Vocal folds
Trachea
Carina of trachea
Main bronchi
Lingular division bronchi
Right lung
Superior lobe
Horizontal fissure
Oblique fissure
Middle lobe
Inferior lobe
Diaphragm
Oral cavity
Esophagus
Capilllary beds
Connective tissue
Alveolar sacs
Alveolar duct
Mucous gland
Mucosal lining
Pulmonary artery
Pulmonary vein
Alveoli
Atrium
Tracheal and bronchi rings
Left lung
Superior lobe
Apex of left lung
Oblique fissure
Cardiac notch
Lingula of lung
Inferior lobe
Superior
Inferior
Middle
Lobar bronchus