HUMAN LOCOMOTION SYSTEM

outline | objectives | key terms

SKELETAL SYSTEM

- Functions
- Structure
- Bone formation, growth and types
- Parts of human skeleton
- Joints
- Disorders
- Homework

- Functions
- Types of muscle tissue
- Structure of muscles
- Muscle contraction
- Energy supply
- Homework

Skeletal System

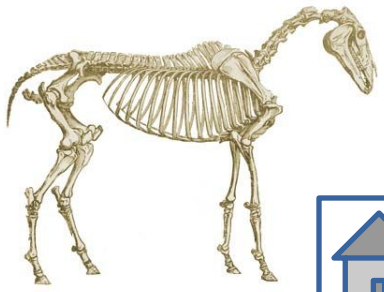
- Skeletal system is the **supportive** and **protective** system of organisms
- <u>There 2 types of skeletal system in organisms:</u>

1. **Exoskeleton**: seen mainly in invertebrates




2. **Endoskeleton**: seen in vertebrates, sea stars, sponges

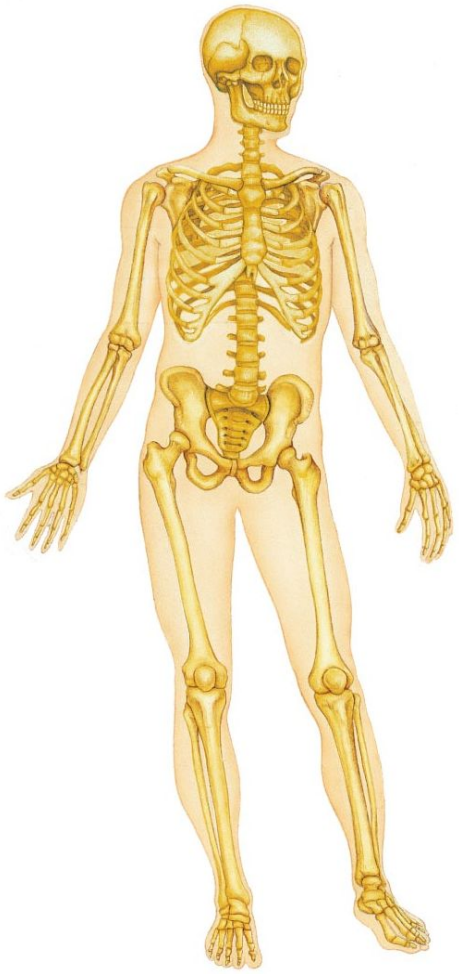


Human Skeletal System

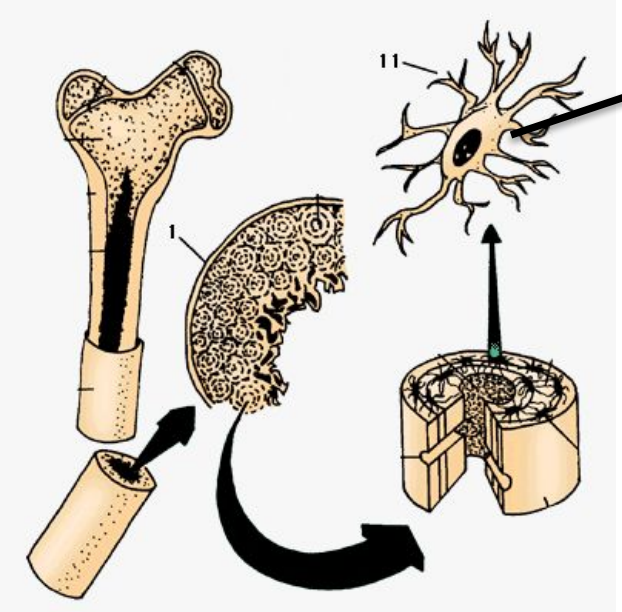
Functions:

- **Supports** the body
- Provides **movement** with the help of muscles
- **Protects** inner organs
- **Produces** blood cells
- **Stores** minerals such as P (phosphorus) and Ca (calcium)

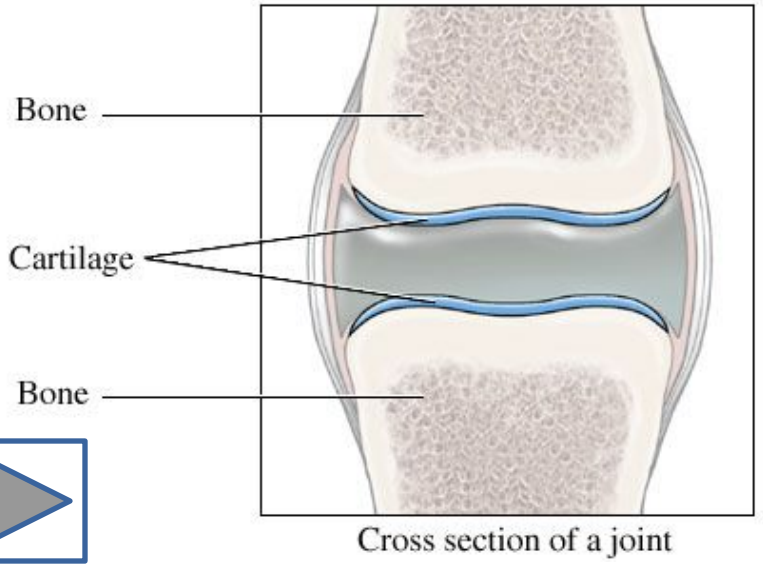


Structure of human skeleton

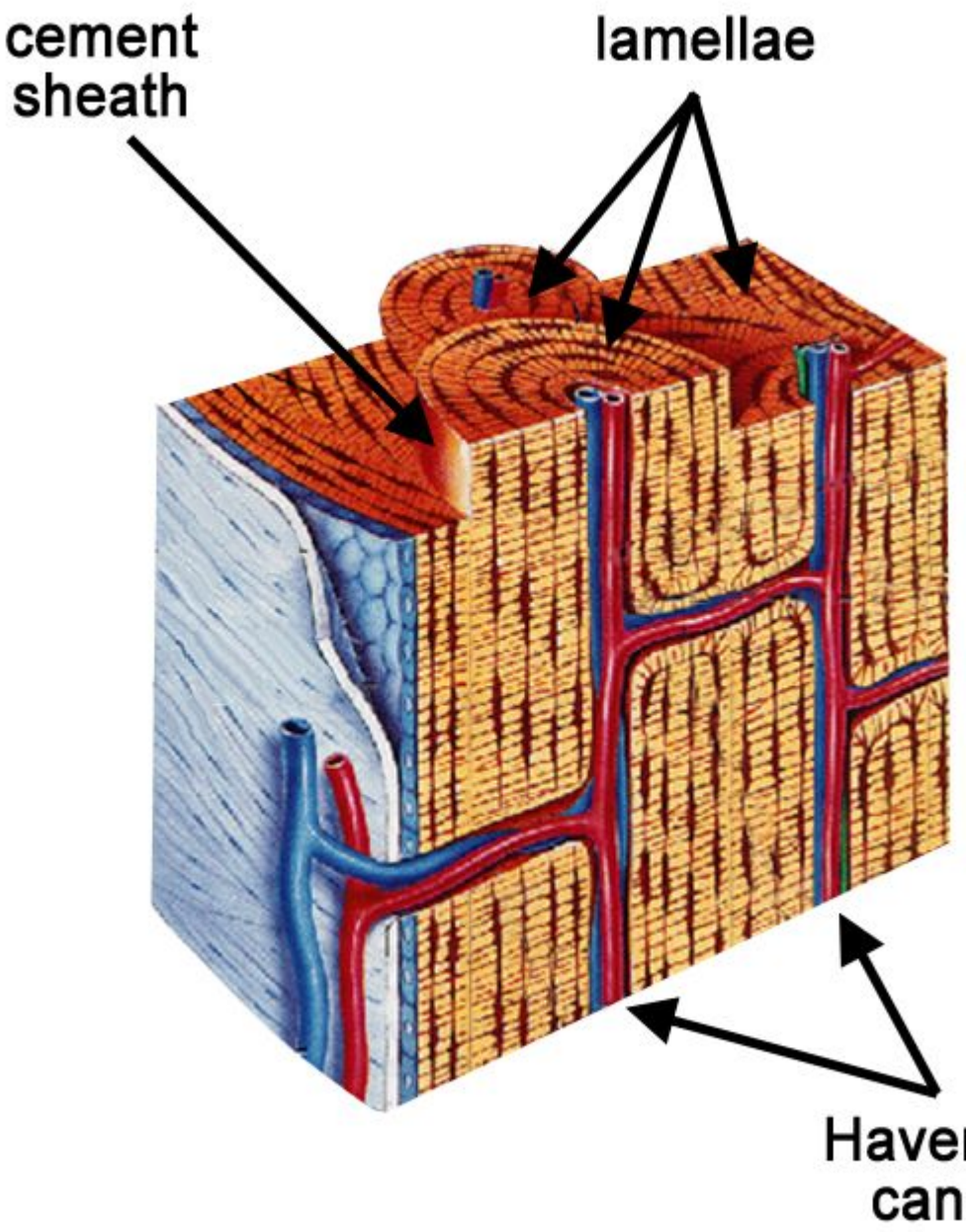
- Human skeleton is composed of **bones** and **cartilage**
- **Bones** are composed of cells known as **osteocytes**
- Osteocytes are arranged **in circles** and connected to each other by cytoplasmic bridges
- There is haversian canal between cicrles, it contains blood vessels and nerves
- Intracellular space is filled by **matrix (ossein)** that contain Ca, P, carbonate and protein.
- **Cartilage** is composed of cells **chondrocytes**

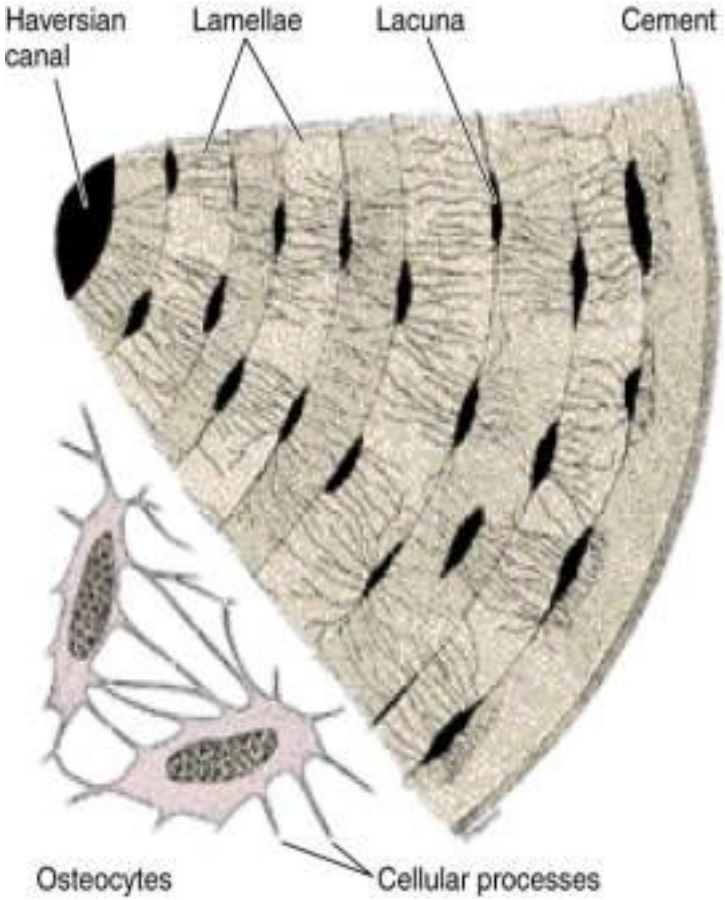


osteocyte



Cross section of a joint


cement sheath
lamellae
Haversian canals

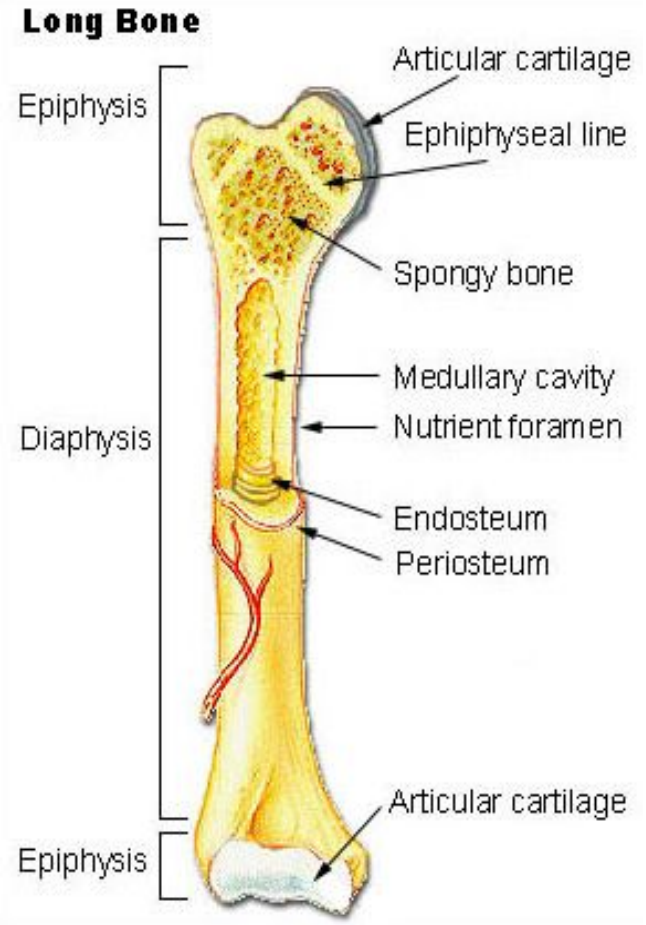

Haversian canal
Lamellae
Lacuna
Cement
Osteocytes
Cellular processes

Bone

- Outer cover of bones known as **periosteum**
- **Periosteum** provides **growth** in diameter and **repair** of bones
- **There are 2 types of bone tissue:**

1. **Compact:** very dense and strong
2. **Spongy:** porous and soft

- Space between bones is filled with **bone marrow**
- **Red bone marrow:** fills space between spongy bones and produces blood cells
- **Yellow bone marrow:** fills hollow interior space of bones



Formation of bone

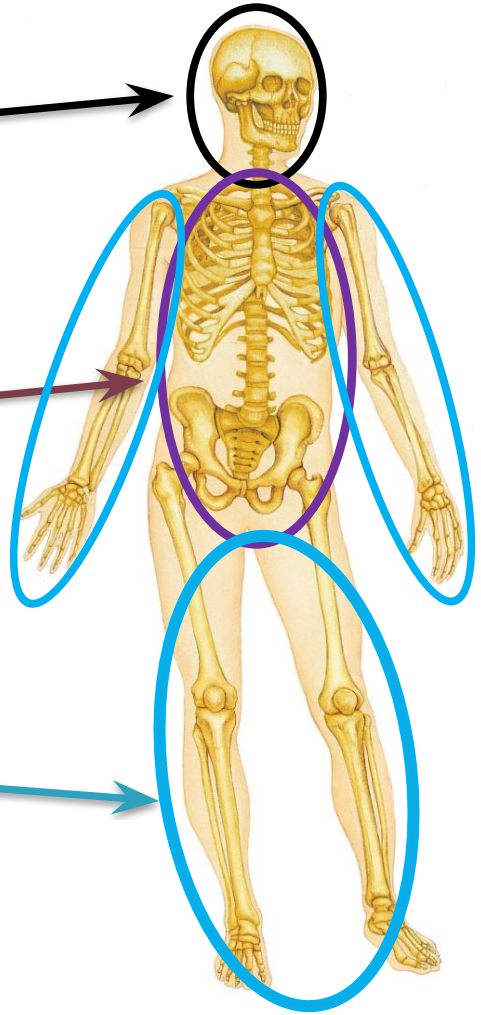
- For bone formation and normal growth **minerals** such as **Ca**, **P** and **vitamins A**, **C** and **D** needed
- **Deficiency** of vitamin **D** causes rickets – рахит, **A** growth rate decreases, **C** causes weakness and disease scurvy – цинга
- **Ca** level in blood is regulated by hormones **parathormone**, released by parathyroid gland, and **calcitonin**, released by thyroid gland
- **Parathormone:** is secreted when Ca level is decreased in blood
- **Calcitonin:** is secreted when Ca level is increased from blood

Types of bones

1. **Long bones:**
   - Ex: bones of legs, arms …
2. **Flat bones:**
   - Ex: bones of skull, rib, patella …
3. **Short bones:**
   - Ex" bones of vertebrae, hand, fingers, foot …

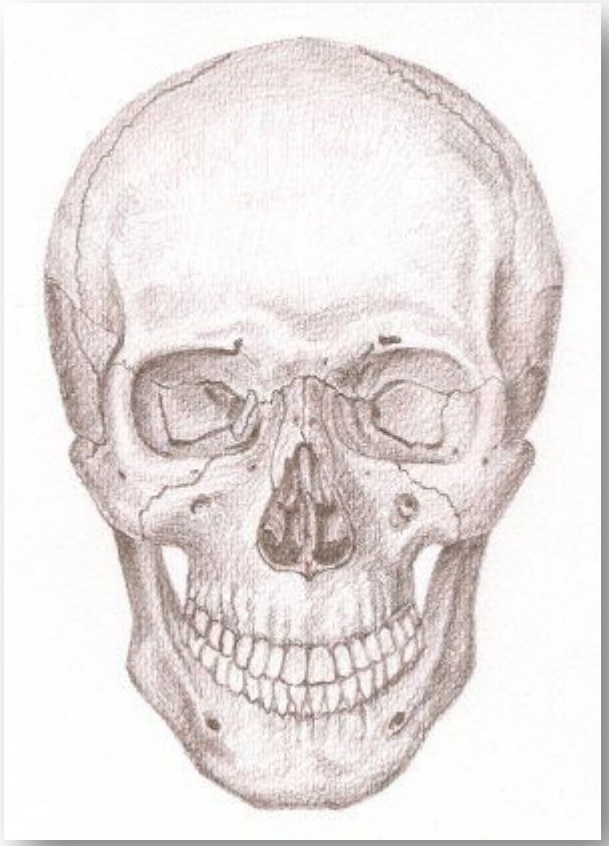
Parts of Human Skeletal System

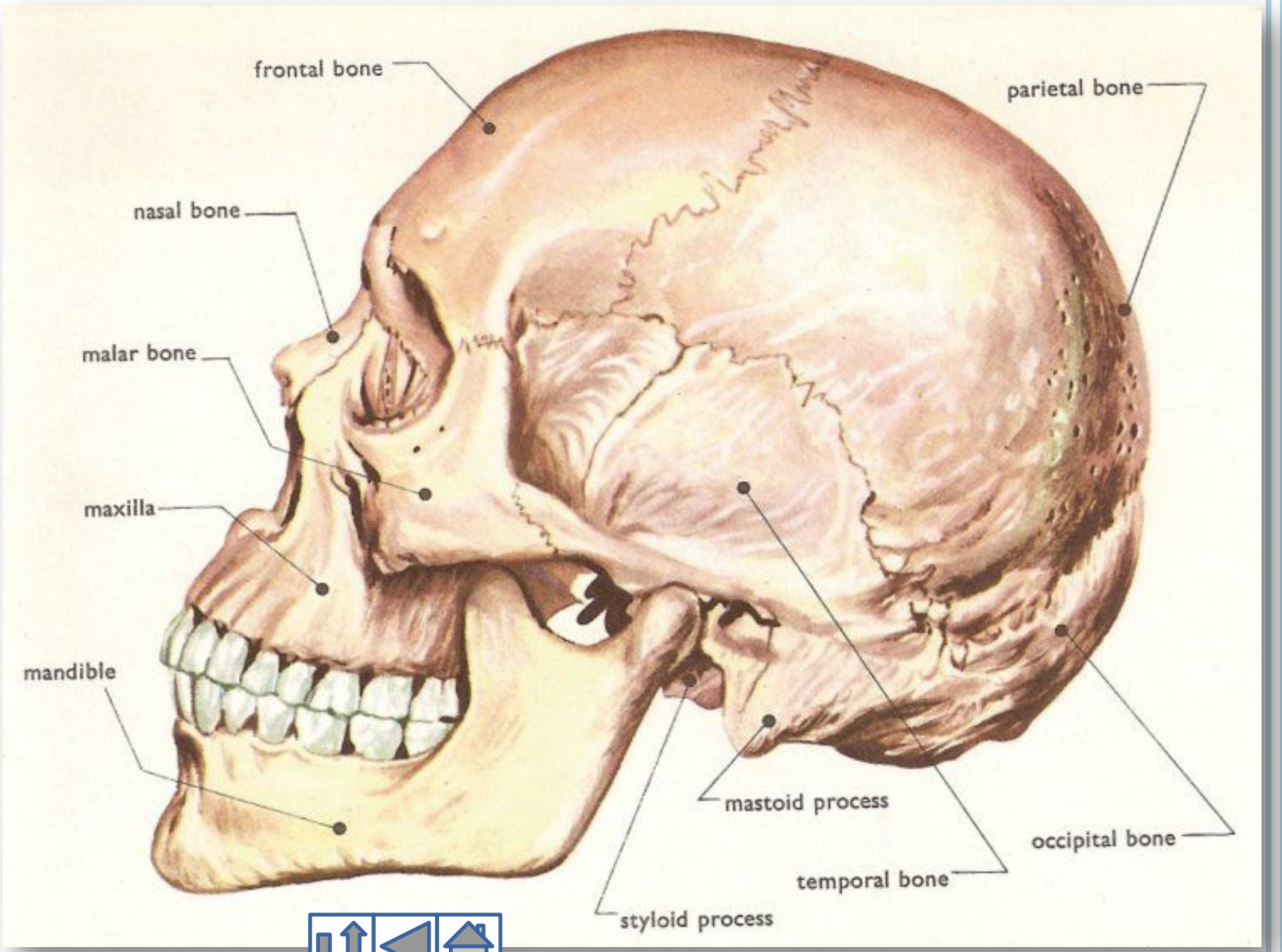
- Adult human contains 206 bones, in babies it is approximately 300
- **Skeleton parts:**
  1. **Skull**
  2. **Trunk**
  3. **Extremites**



1. Skull

- Skull includes **22 bones**
- **8** of them **cranial**, **14** are **facial** bones
- Cranial bones are fused to each other and **immovable**



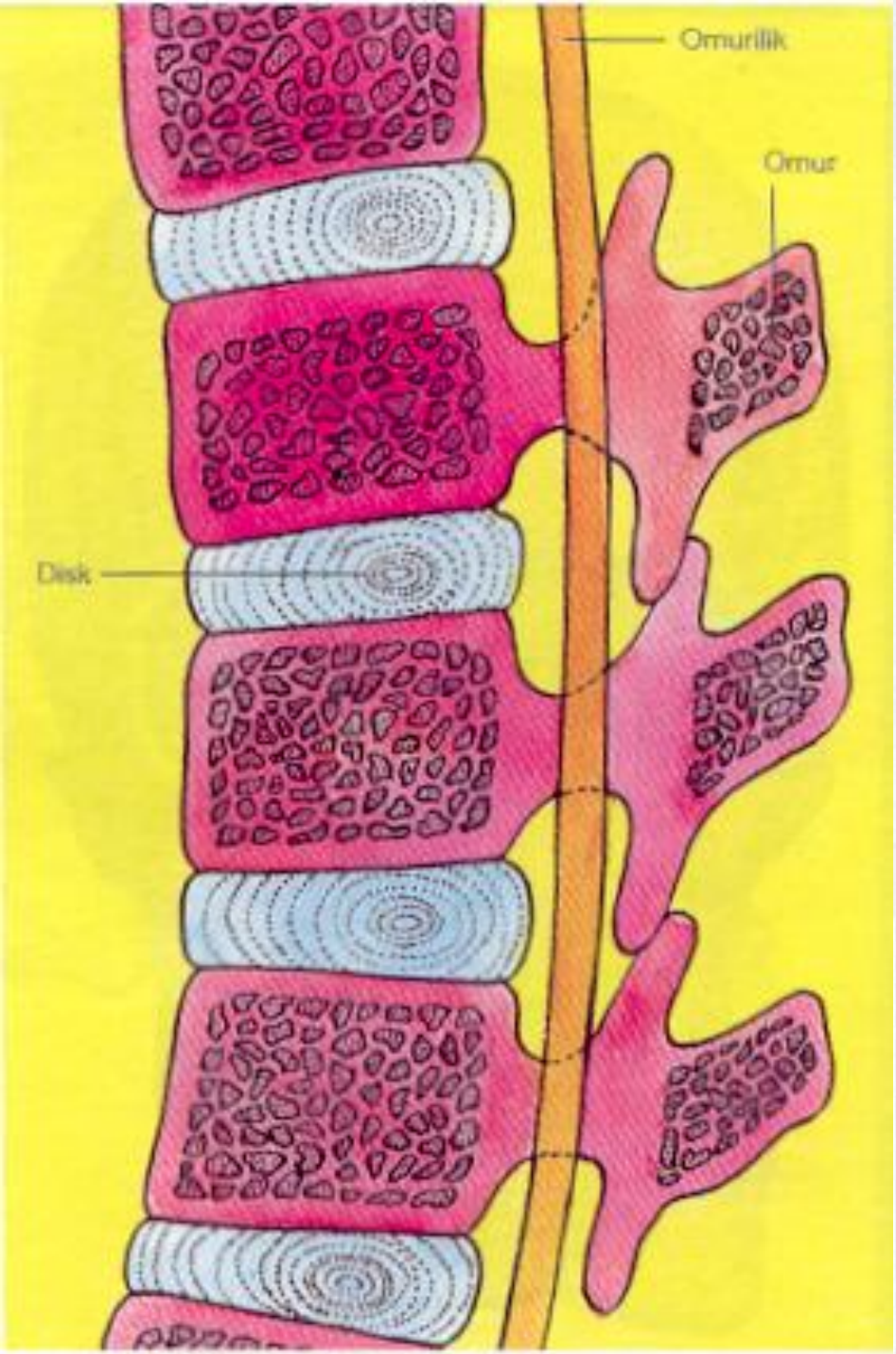

frontal bone
parietal bone
nasal bone
malar bone
maxilla
mandible
mastoid process
occipital bone
temporal bone
styloid process

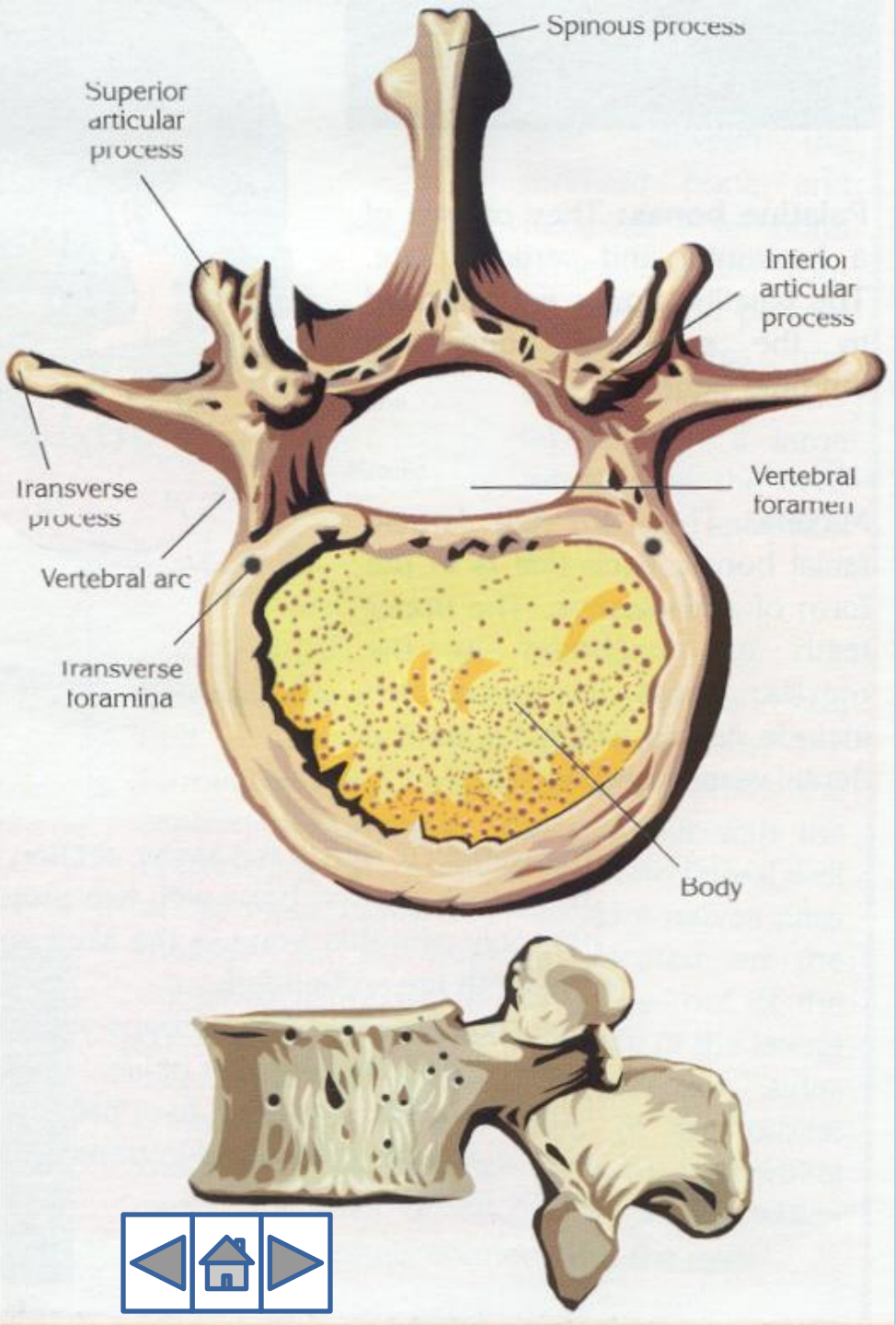
2. Trunk

- **Trunk** includes **vertebral column**, **ribs**, **sternum**, **pelvic girdle** and **pectoral girdle**

Vertebral column:

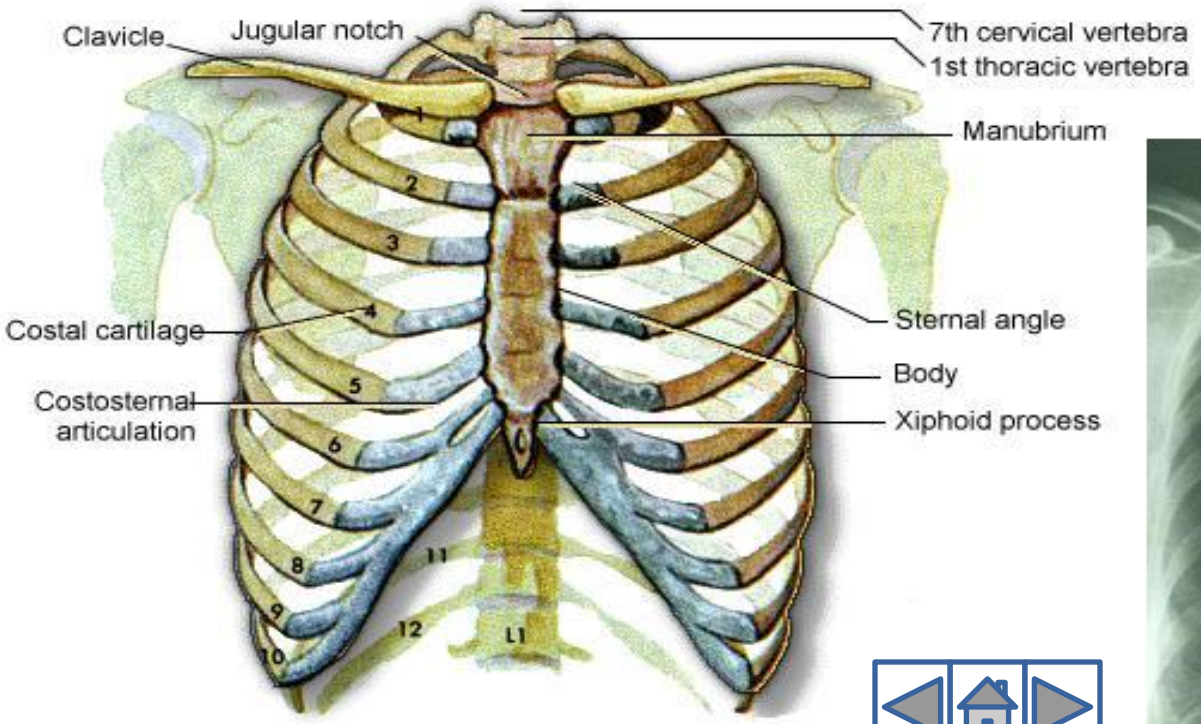
- Vertebral column consists of **33 vertebrae**
- Between each vertebrae there is **cartilaginous disc**, and vertebral column is slightly movable
- Vertebral column protects **spinal cord**
- Upper end connected to **Skull**, lower end to **Sacrum**


Omurilik
Omur
Disk


Spinous process
Superior articular process
Inferior articular process
Transverse process
Vertebral foramen
Vertebral arc
Transverse foramina
Body

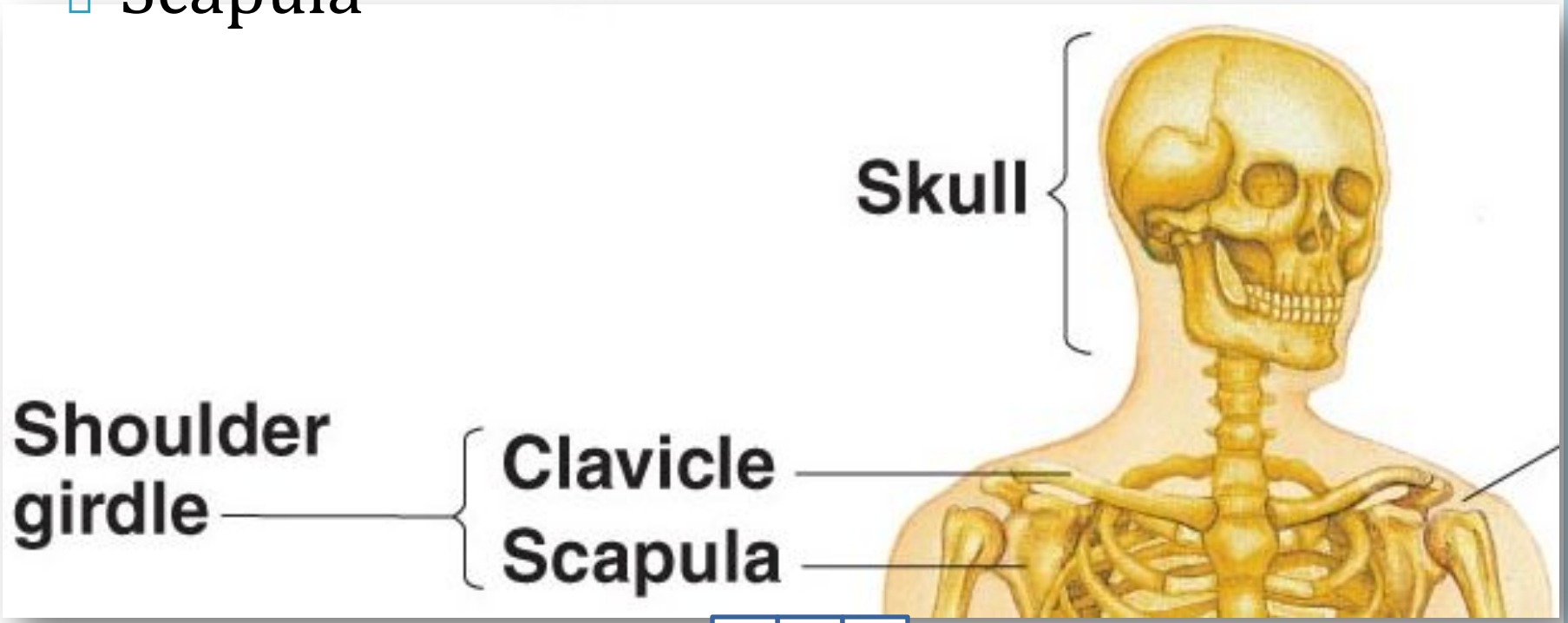
Chest

- It **protects** heart and lungs that has **12 pairs of ribs** and a **sternum**.
- All ribs are **connected** to vertebrae on the back side.
- Ribs are connected to sternum in the abdomen. But **11th and 12th ribs** are **free floating** ribs.



Pectoral girdle – плечевой пояс

- **It includes 2 paired bones that hold up arms:**
- Clavicle
- Scapula

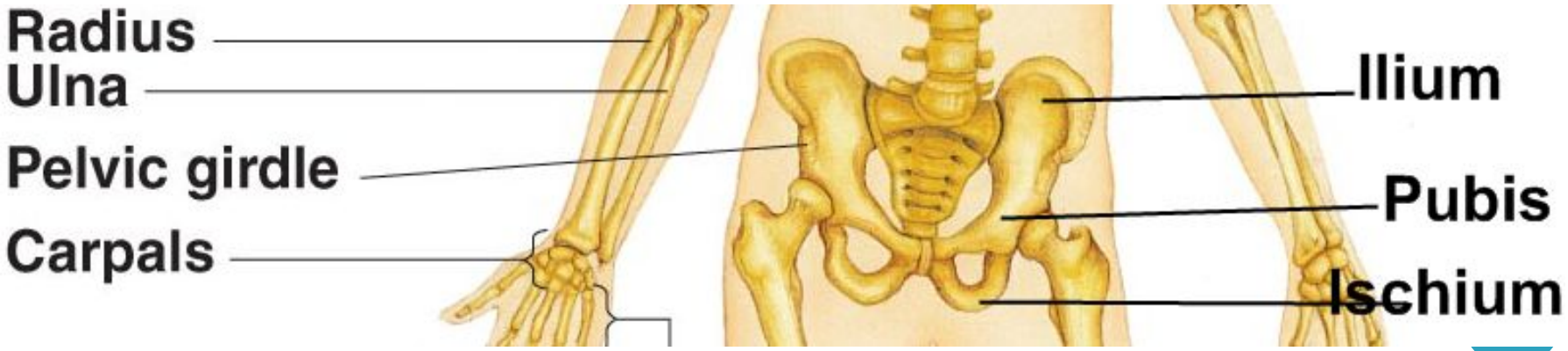


Pelvic girdle – тазовый пояс

- It is connected to the lower end of vertebral column (sacrum)
- It holds **legs** and **reproductive organs**

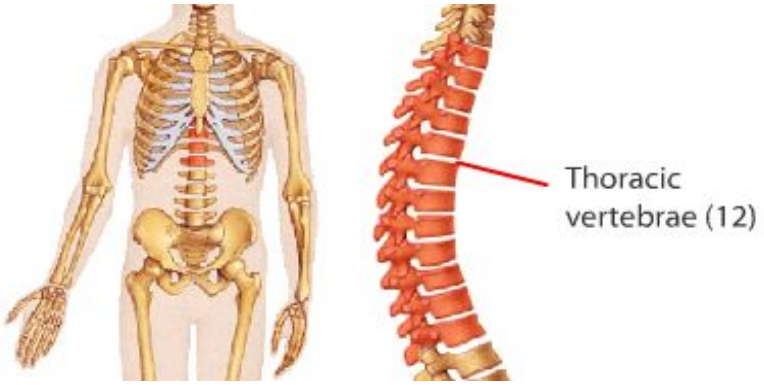
Includes:

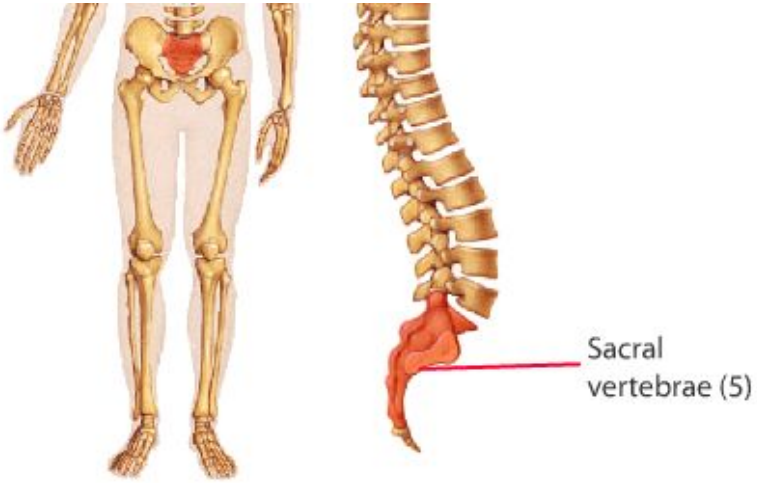
- Ilium
- Ischium
- Pubis



Vertebral column is divided into 5 parts

- 1. **Cervical or neck** – 7 vertebrae
- 2. **Thoracic** – 12 vertebrae
- 3. **Lumbar** – 5 vertebrae (largest)
- 4. **Sacral** – 5 fused vertebrae
- 5. **Coccyx or tailbone** – 3 to 5 fused vertebrae





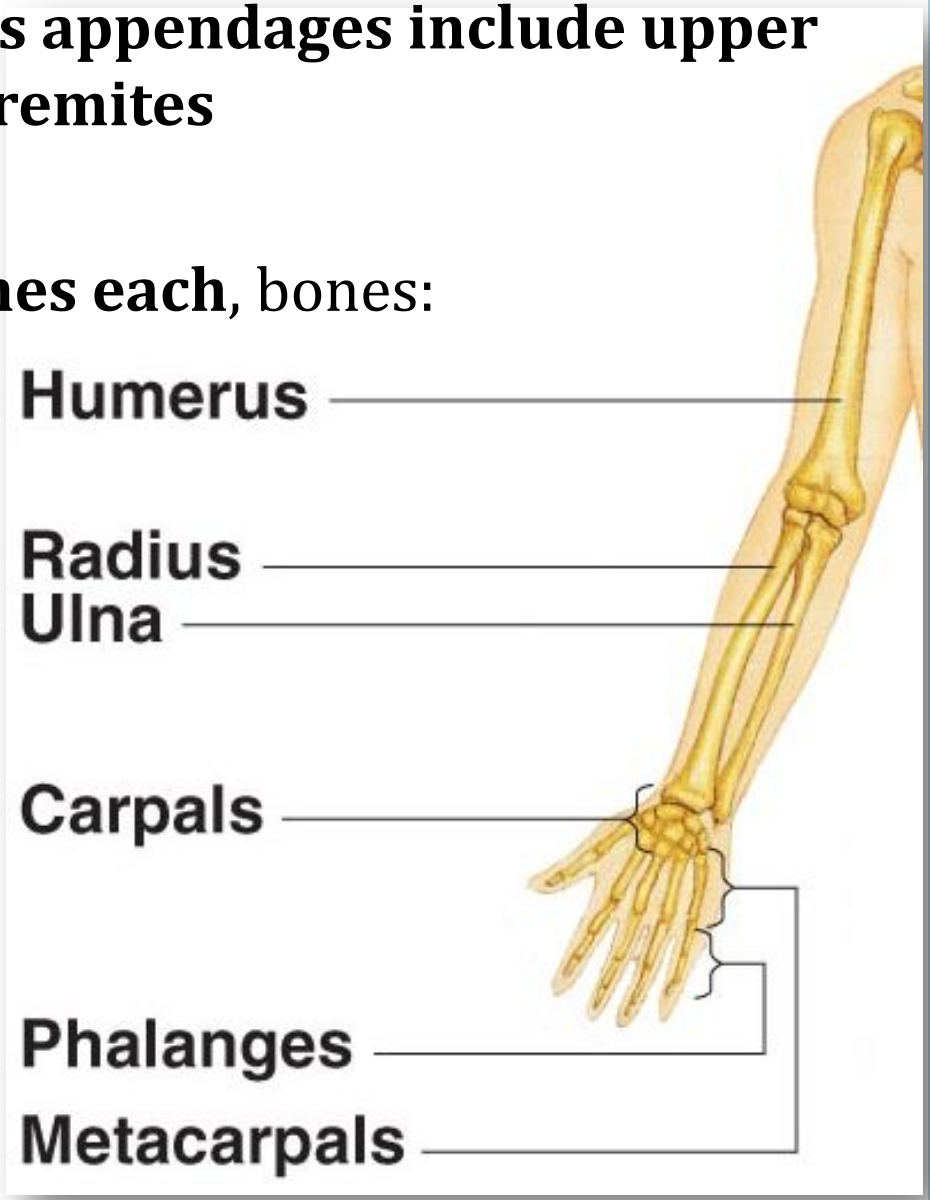
3. Extremites - КОНЕЧНОСТИ

- **Extremites in other words appendages include upper extremites and lower extremites**

a. **Upper:**

2 arms and include **30 bones each**, bones:

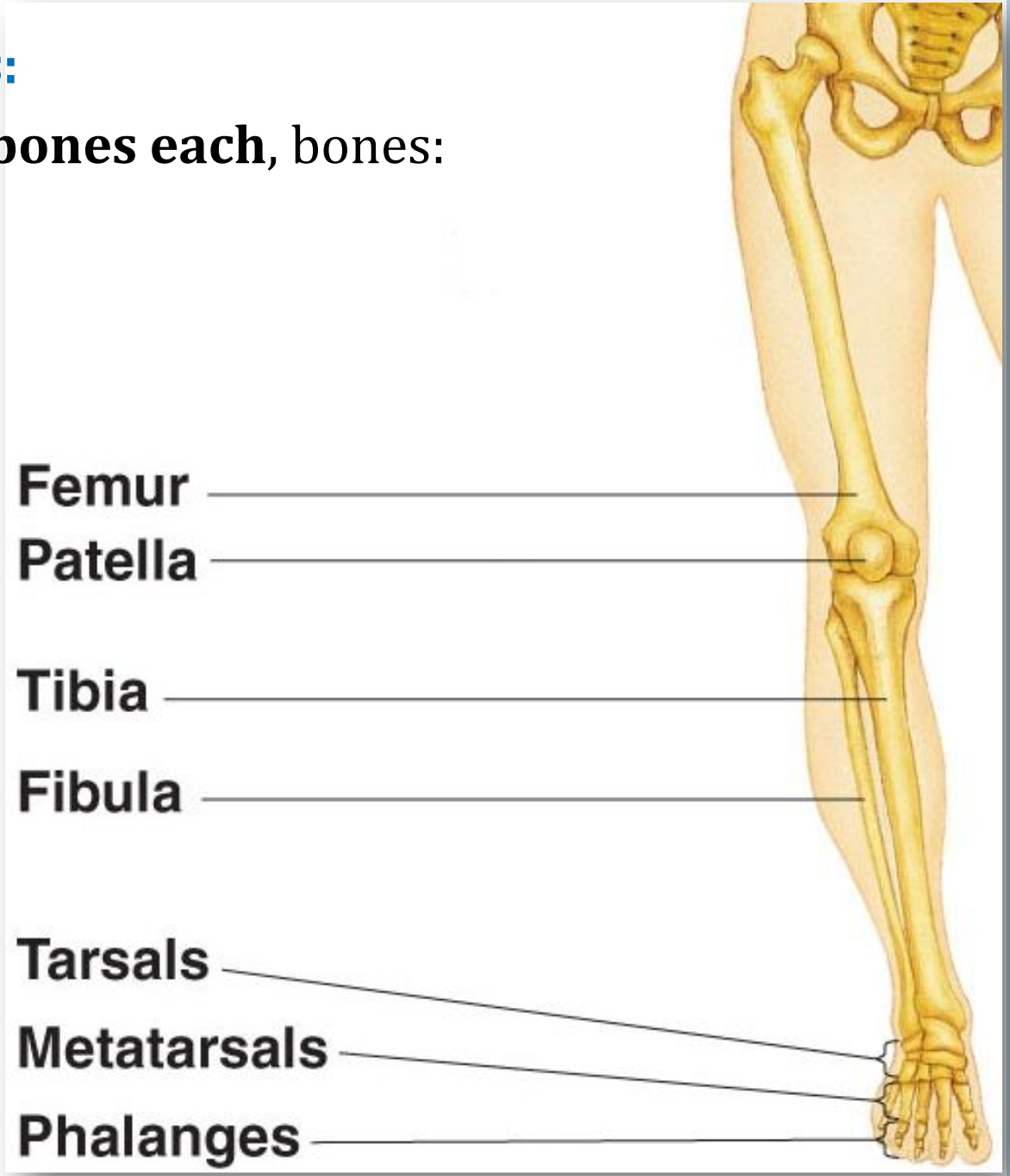
- Humerus 1*2
- Ulna 1*2
- Radius 1*2
- Carpals 8*2
- Metacarpals 5*2
- Phalanges 14*2

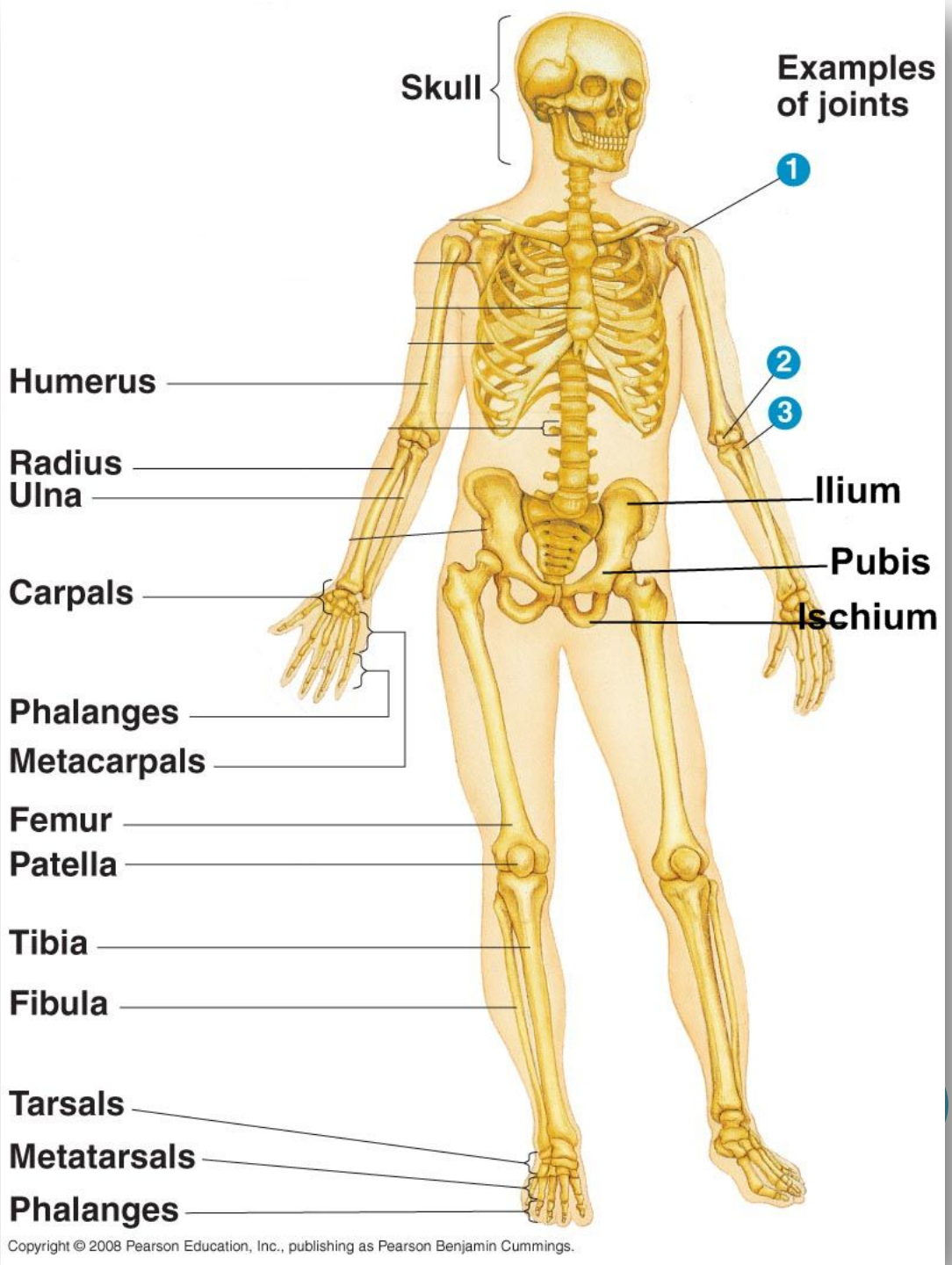


b. Lower extremites:

2 legs, include **30 bones each**, bones:

- Femur 1*2
- Patella 1*2
- Tibia 1*2
- Fibula 1*2
- Tarsals 7*2
- Metatarsals 5*2
- Phalanges 14*2





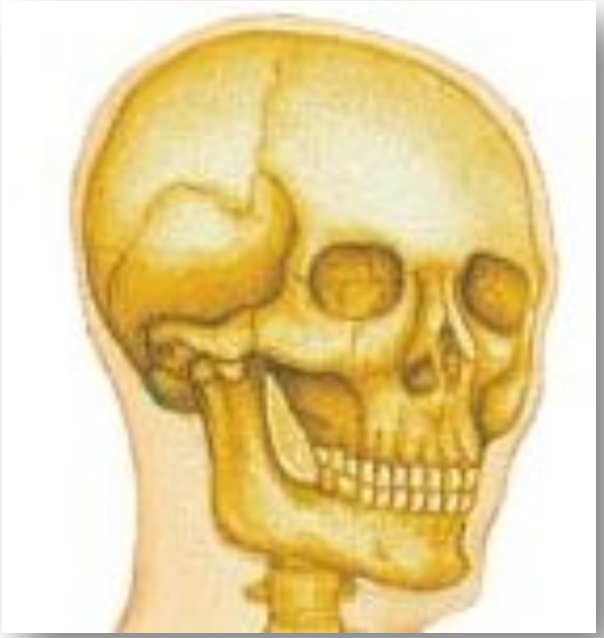
JOINTS

- Joint forms the junction between two or more bones
- **There are three types of joints;**

1. Immovable joints
2. Slightly movable joints
3. Movable joints

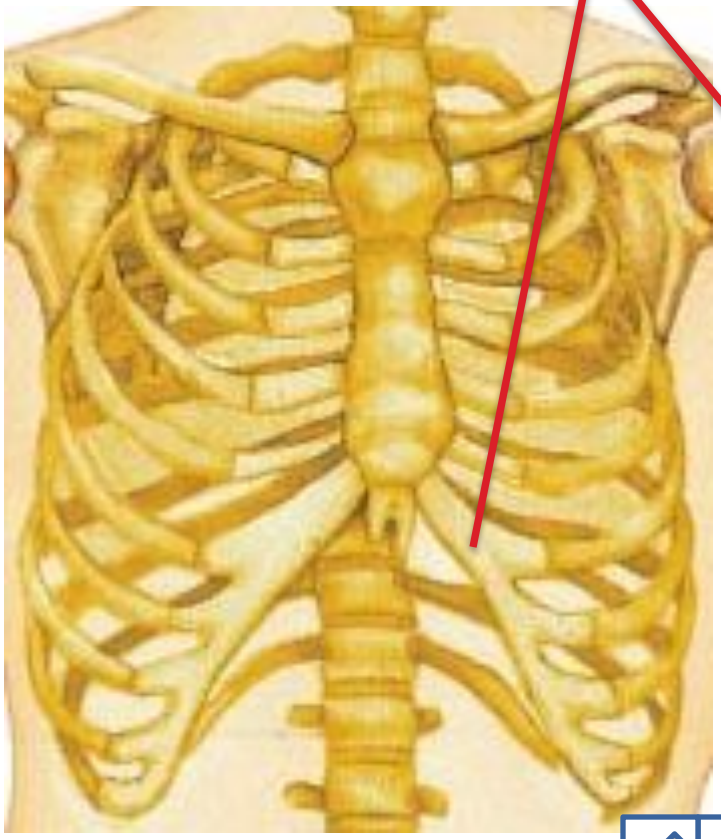
1. Immovable joint

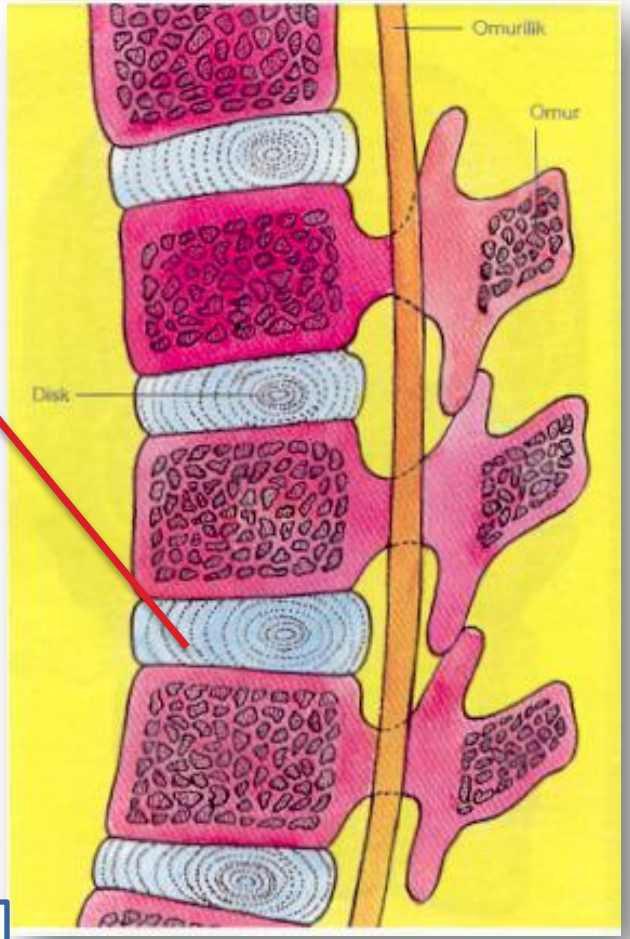
- Jointed bones **cannot move**
- All **cranial** and **facial** bones except mandible and **sacrum** are immovable
- There is **no synovial fluid** between bones



2. Slightly movable joints

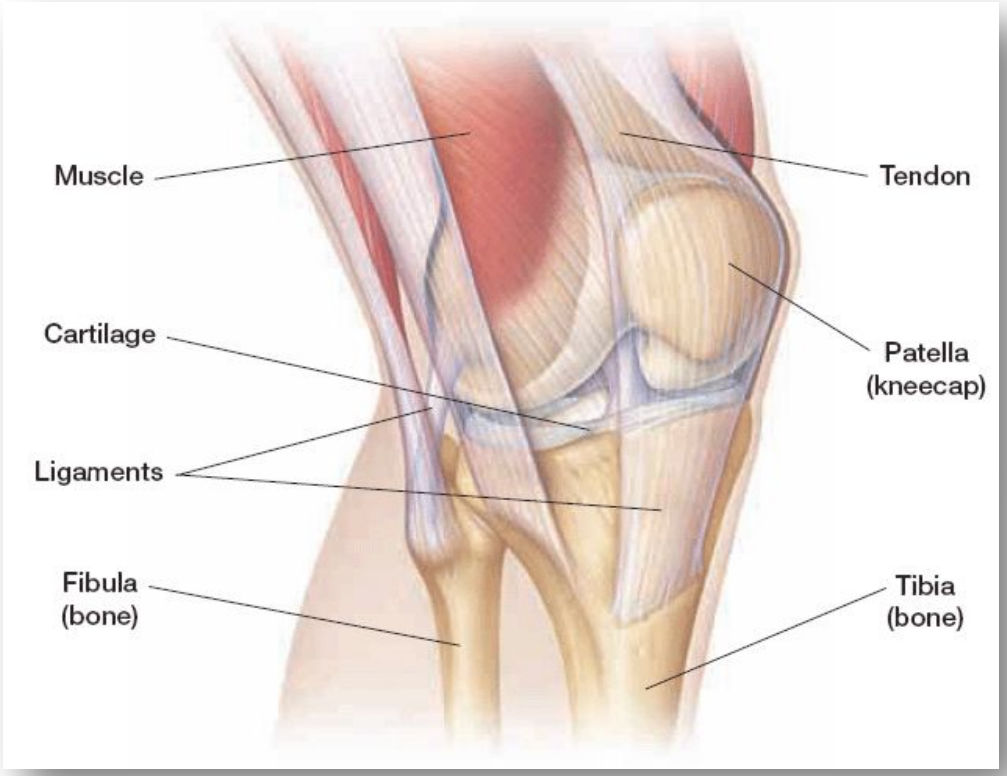
- Connected by **cartilage** or **connective tissue**
- **Vertebrae** are connected by cartilage and **ribs to sternum** also connected by cartilage

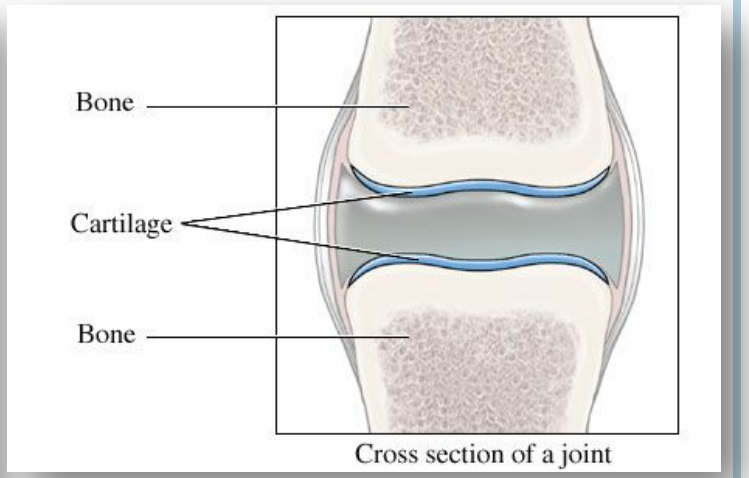




3. Movable joints

- The bones in movable joints are connected to each other by **ligaments** (*very strong connective tissue fibers*).
- There is a **synovial fluid** and **cartilage** in movable joints which reduce **friction**.

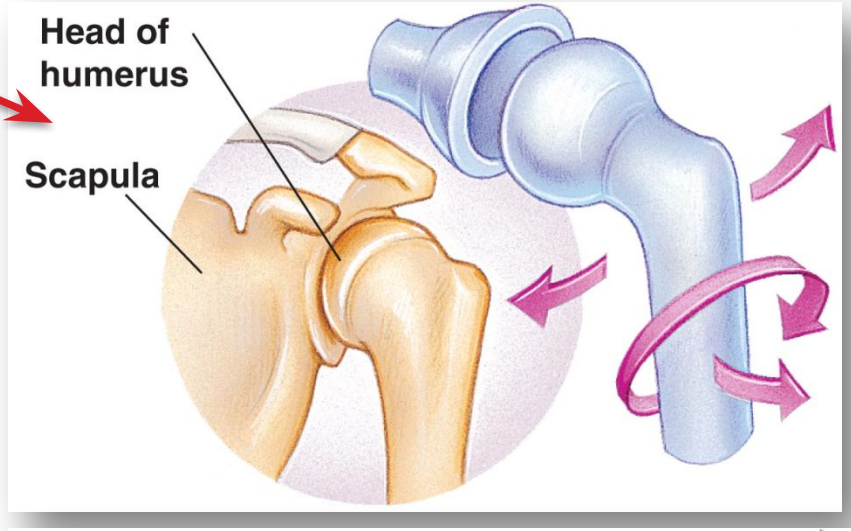


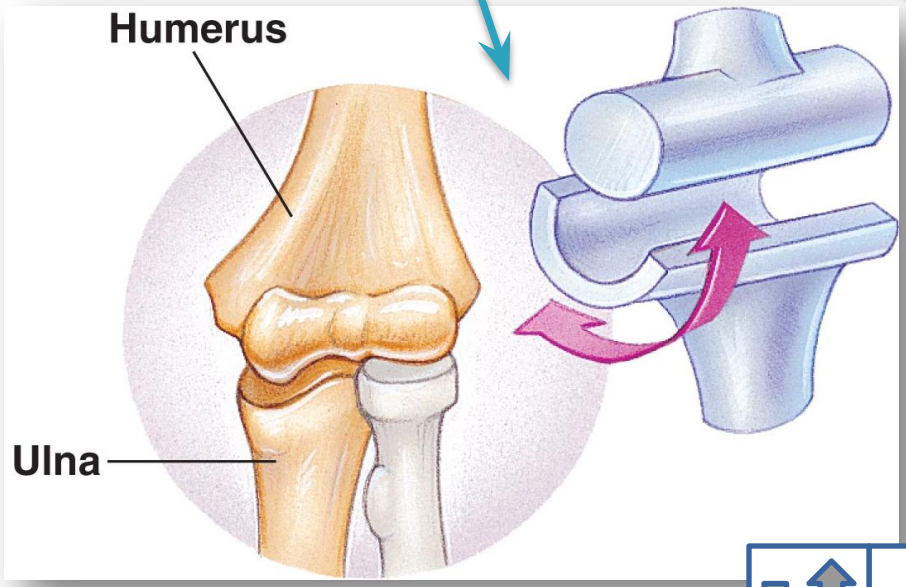


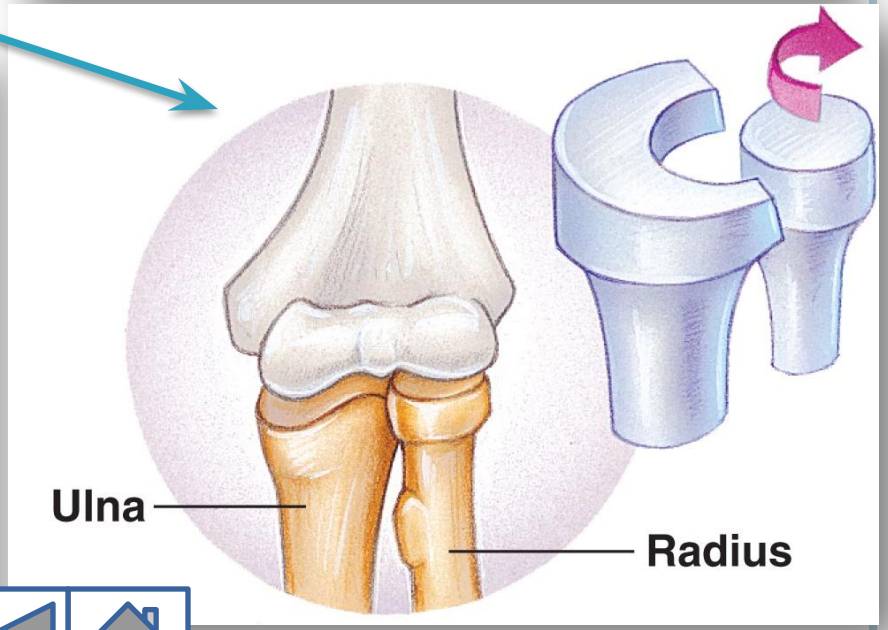
Cross section of a joint

Types of Movable Joints

- Ball-and-socket
- Hinge
- Pivot

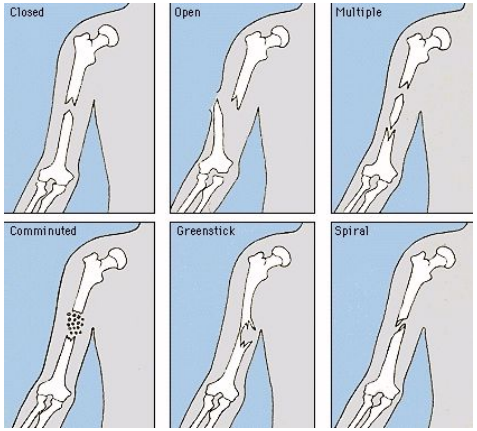






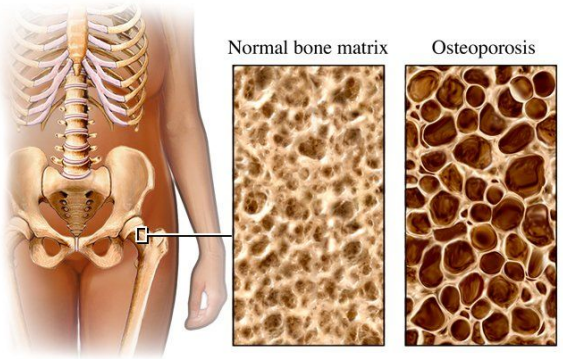
Disorders and diseases of human

SKELETAL SYSTEM



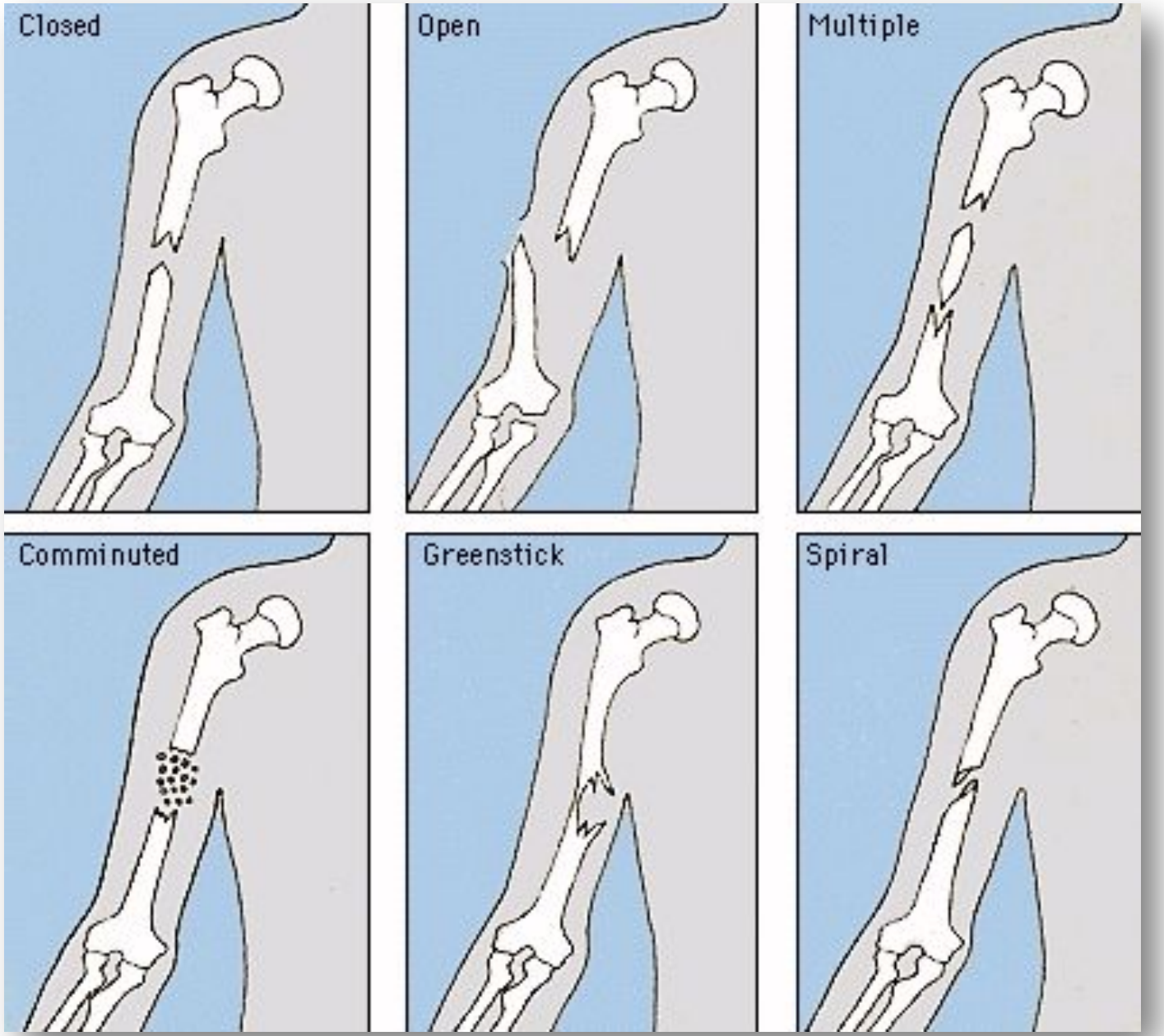
- **Fractures** – is a broken bone because of high physical impact or some other bone disorders

- Osteoporosis – disease which occurs when there is not enough deposition of calcium in bones and because of that bones get weaker

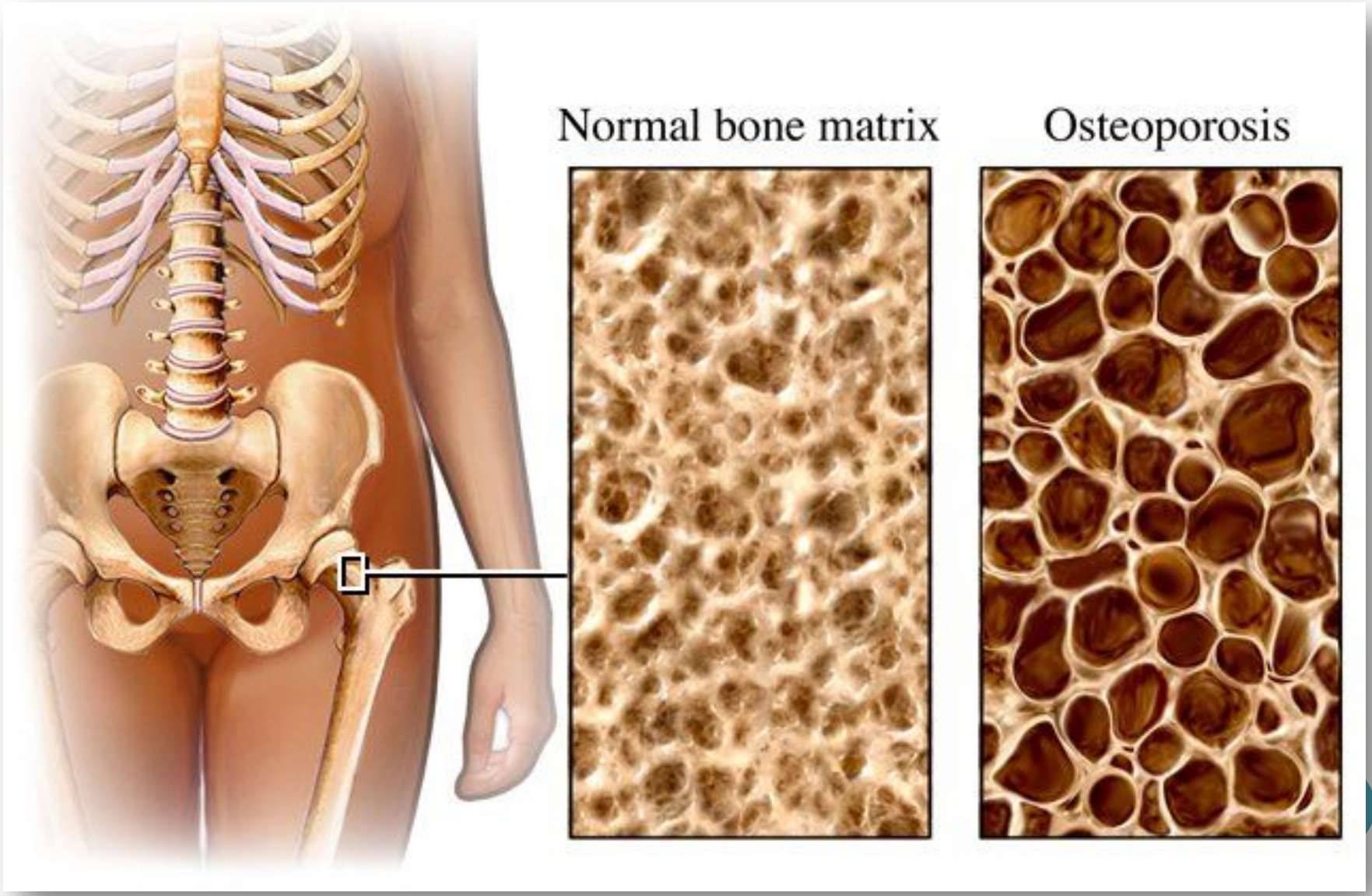


- Rheumatism
- Arthritis
- Scurvy
- Scoliosis

Types of fractures

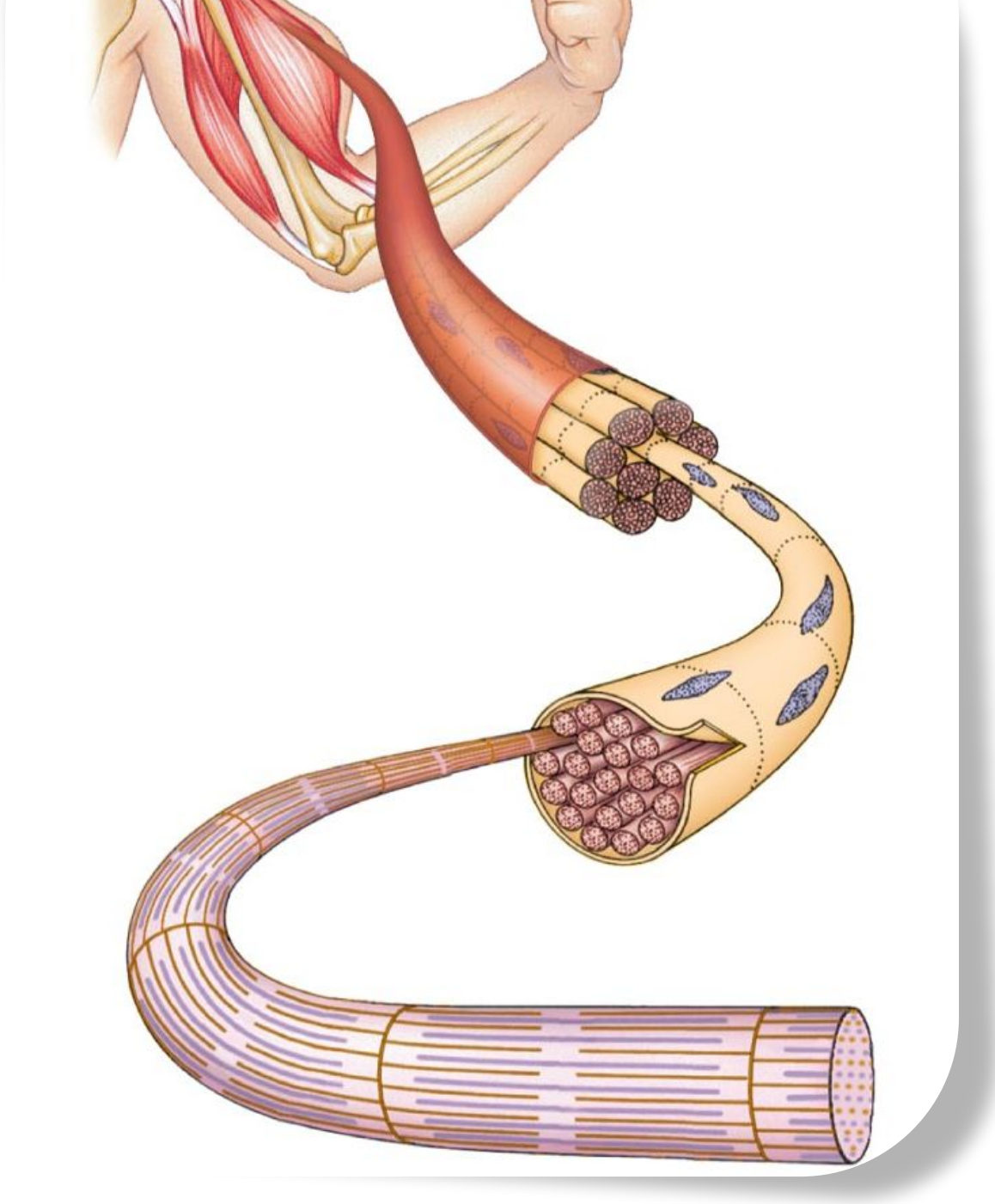


Osteoporosis



Muscular system

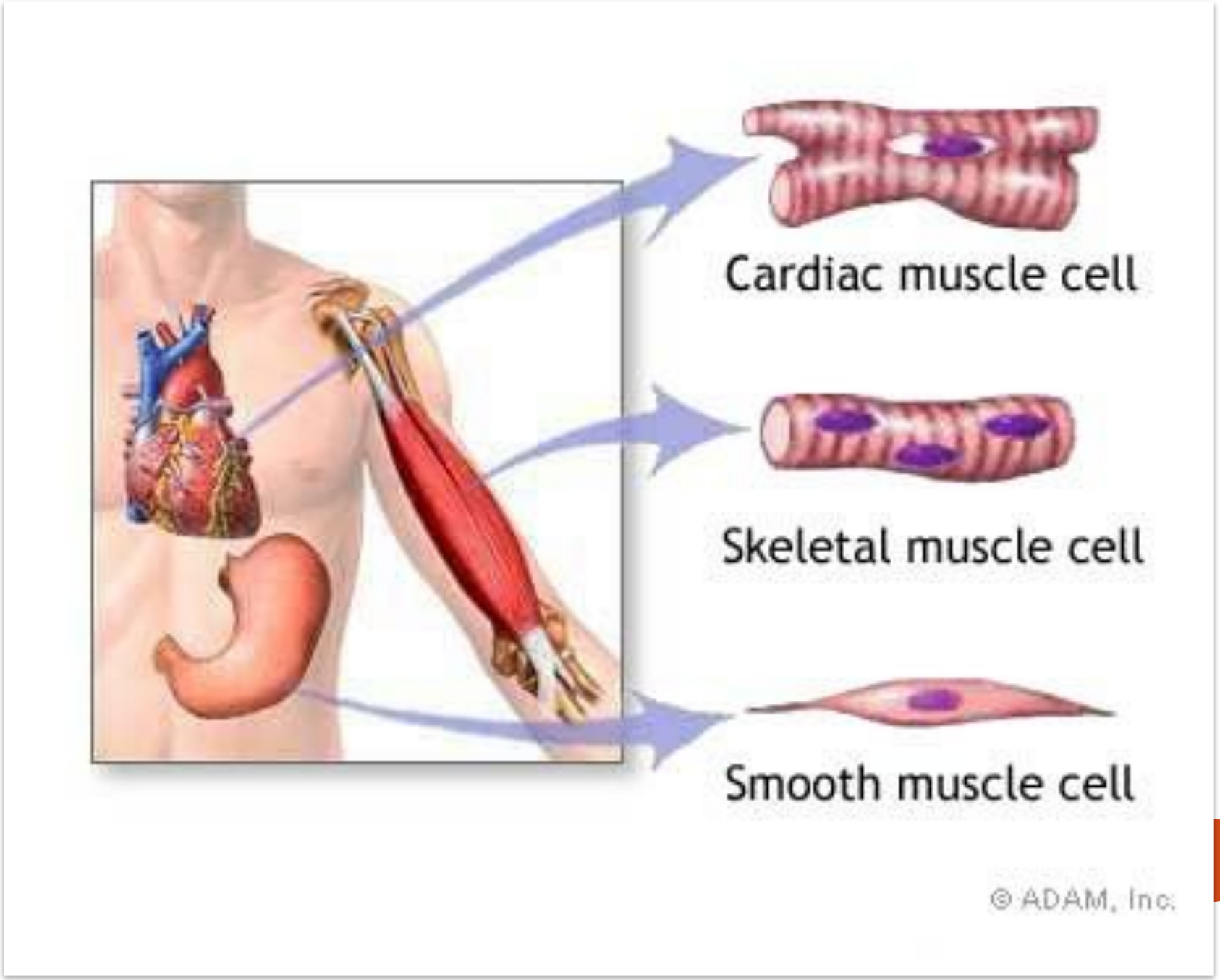
- Muscular system helps in the **movement of body, inner organs** and also helps in protection of **body organs**
- The units of muscular system are cells known as **myofibrils**
- Myofibrils have the ability to **contract** and **relax**



Types of muscular tissue

- There are **3 types** of muscular tissue, they are:

1. **Smooth muscle**
2. **Skeletal muscle**
3. **Cardiac muscle**


Cardiac muscle cell
Skeletal muscle cell
Smooth muscle cell
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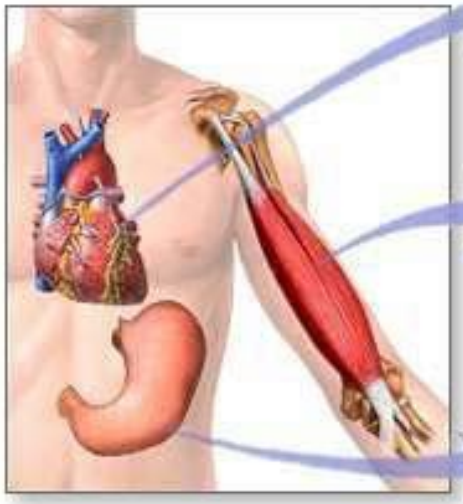
1. Smooth muscle

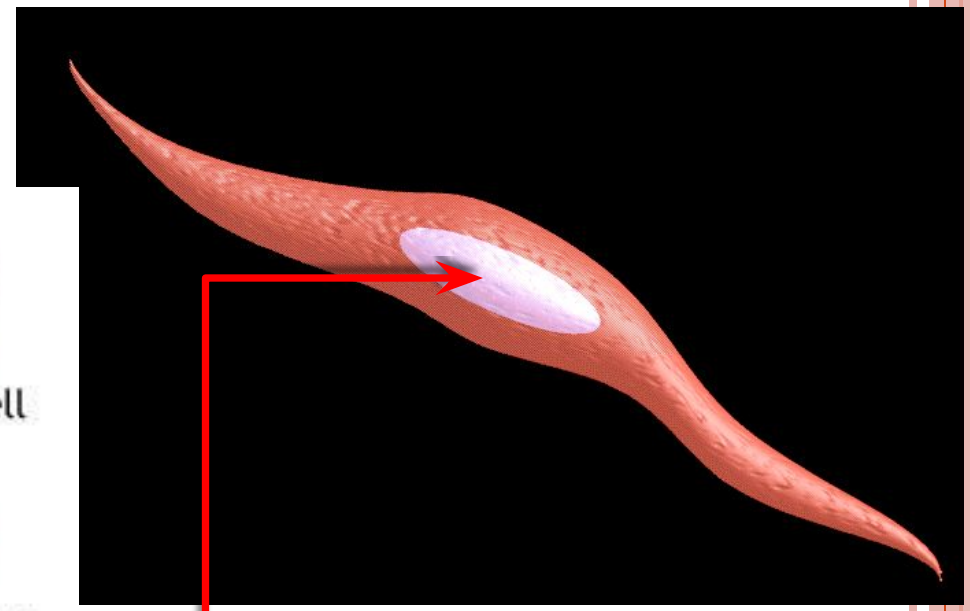
- Each cell is **long**, **sharp-ended** with a **single** central **nucleus**
- Smooth muscles generally regulated by the **Autonomic Nervous System** (ANS)
- Their movement is generally **irregular** and **slow**
- They are found in the **walls of inner organs**, like stomach, intestine, blood vessels, urinary bladder etc.

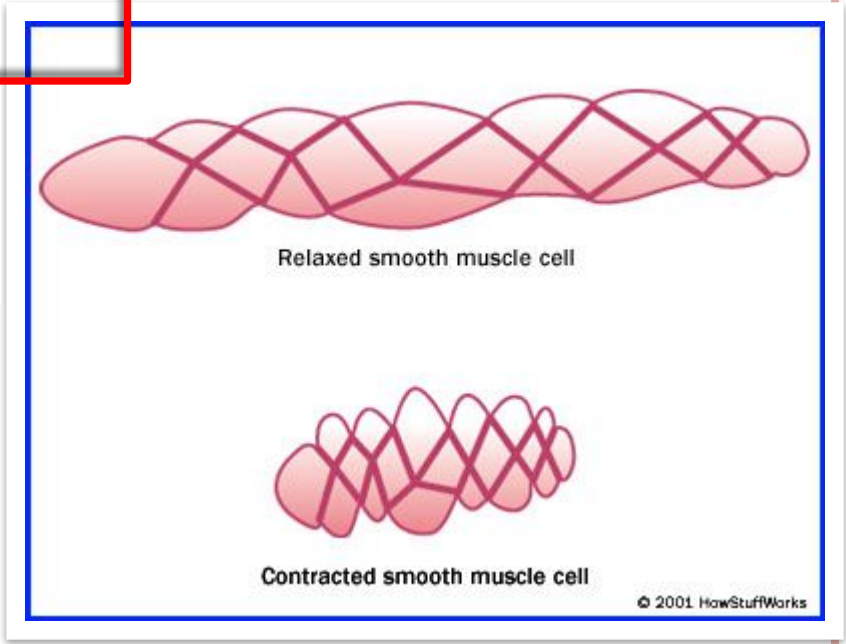


Cardiac muscle cell

Skeletal muscle cell

Smooth muscle cell

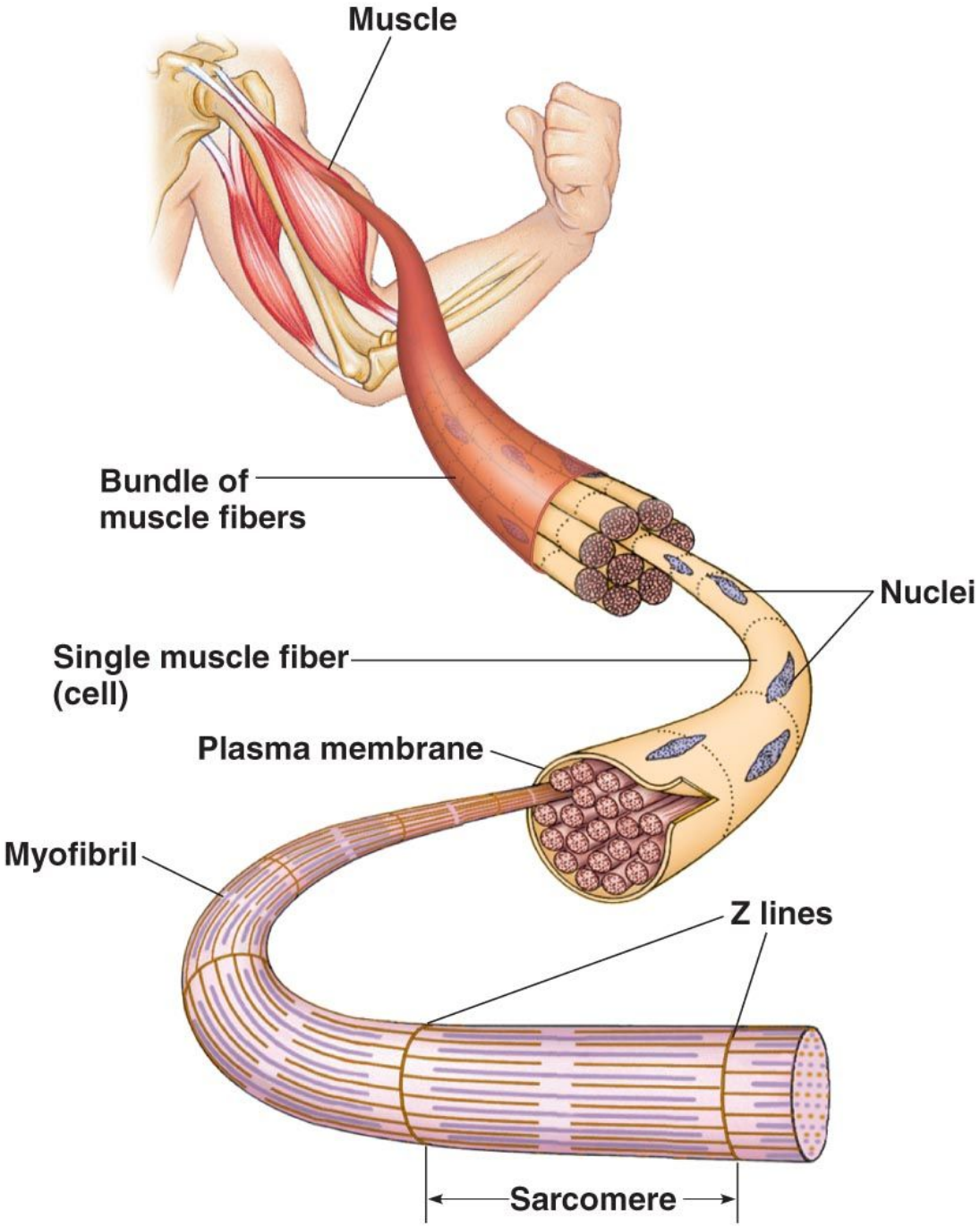




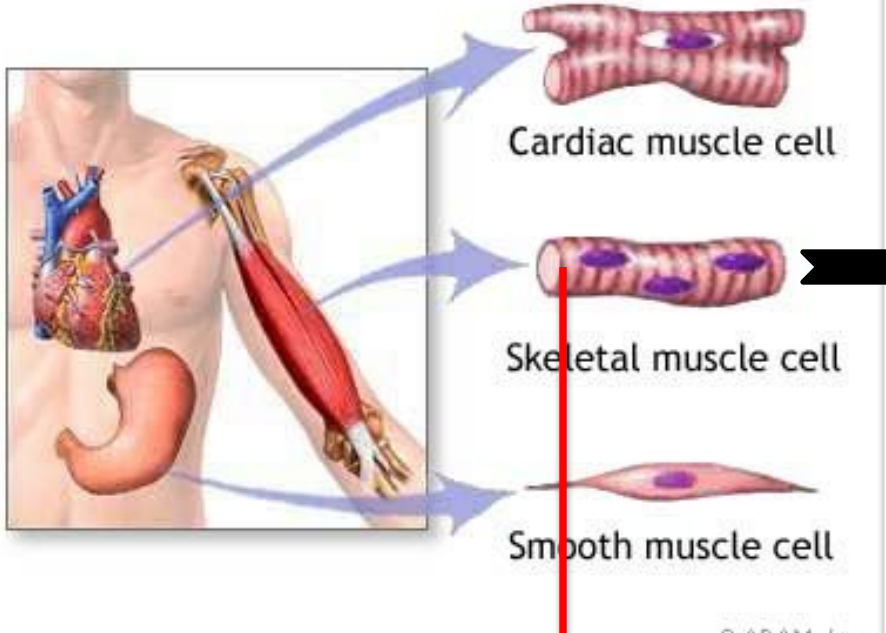
2.Skeletal or striated muscle

- Cells are **long**, **cylindrical** and **multinuclear**, i.e. have many nucleuses
- They are also termed as **muscle fibers**, because they are not branched
- **The structure of skeletal muscles:**

  Muscle bundles, muscle fibers, myofilaments (**actin** and **myozin** proteins)


Muscle
Bundle of muscle fibers
Nuclei
Single muscle fiber (cell)
Plasma membrane
Myofibril
Z lines
Sarcomere

- Skeletal muscles **cover the skeleton**
- They provide **movement of skeleton** and by that body
- It is controlled by brain, by **Somatic Nervous System (SNS)**
- It contracts **rapidly**
- When it is overworked, maximal potential power is used, it gets hardened and this state is called as **tetanus** (судороги)


Cardiac muscle cell
Skeletal muscle cell
Smooth muscle cell
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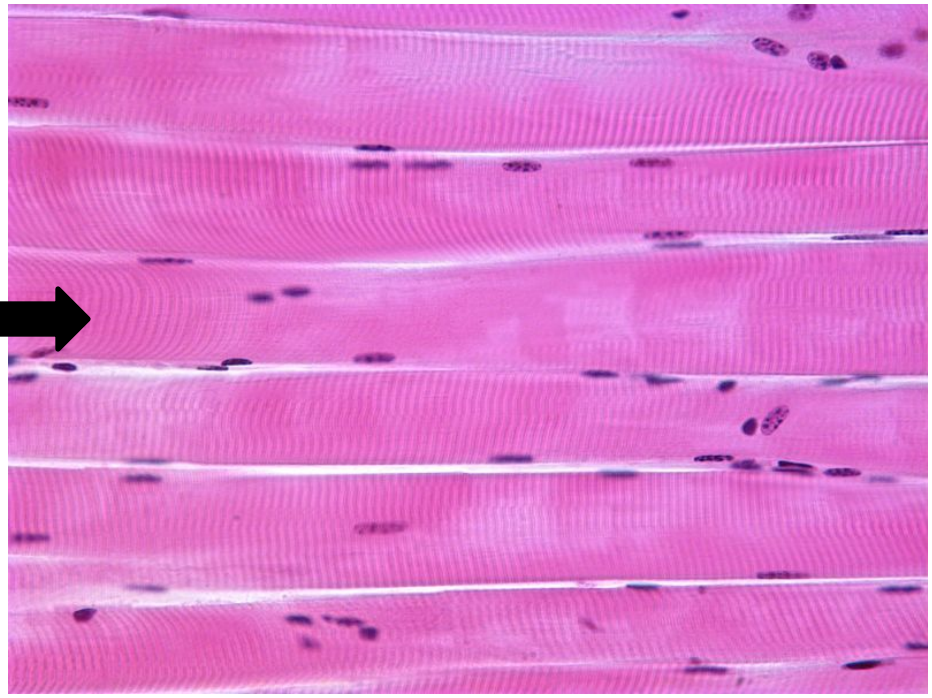
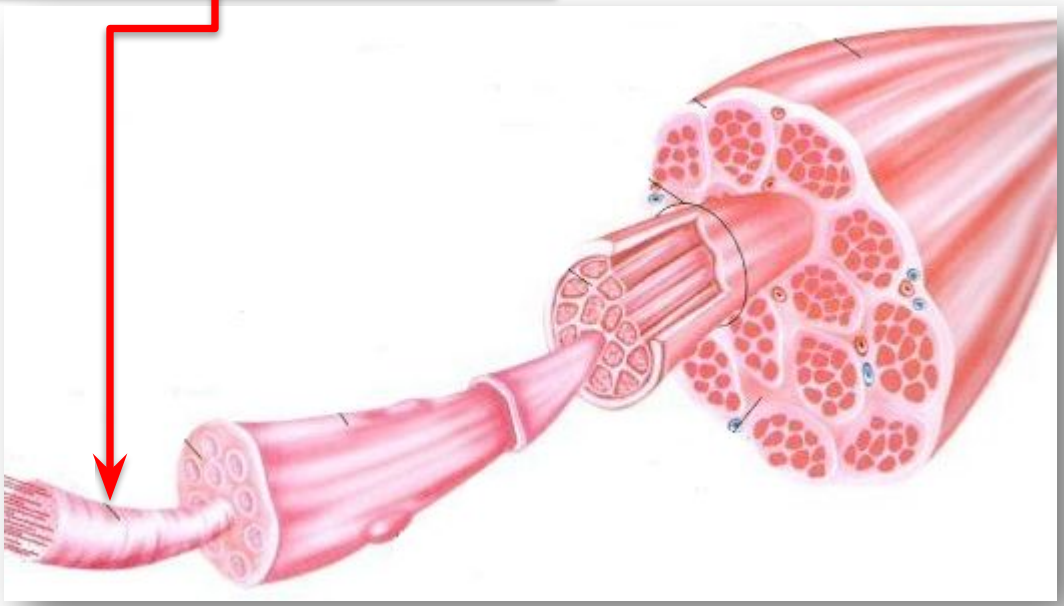
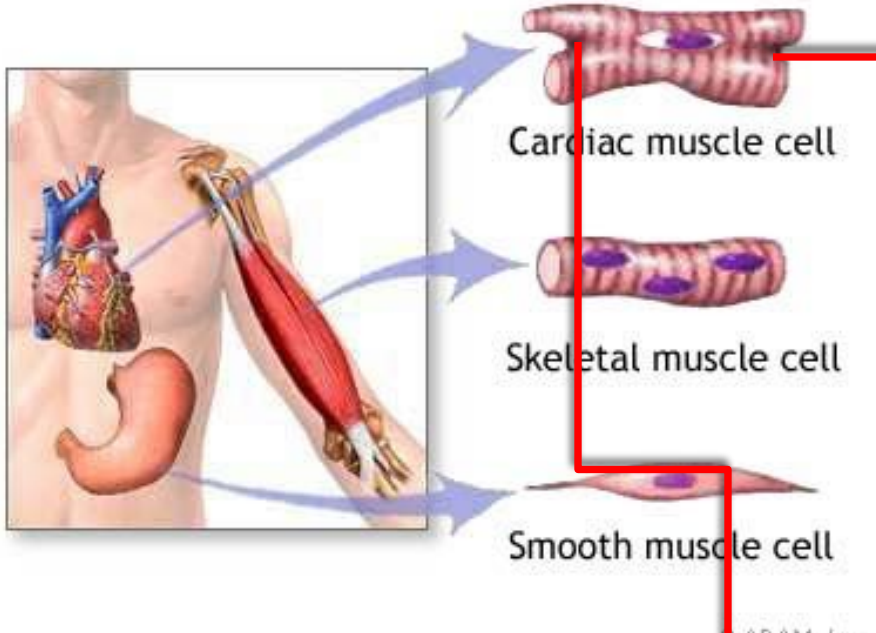




3.Cardiac muscle

- Cells are **long**, **cylindrical**, **branched** and with **1 nucleus** in the center of the cell
- They have **more mitochondria** than skeletal muscles
- Each cell is **rich in blood** and **lymph** vessels
- They are controlled by **ANS**
- Cardiac muscles function **involuntarily**


Cardiac muscle cell
Skeletal muscle cell
Smooth muscle cell
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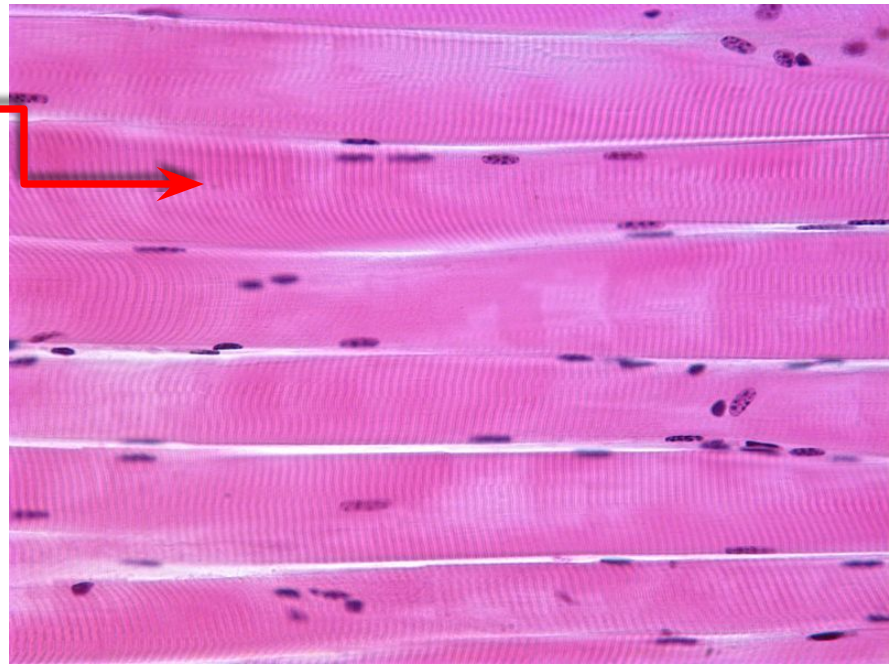
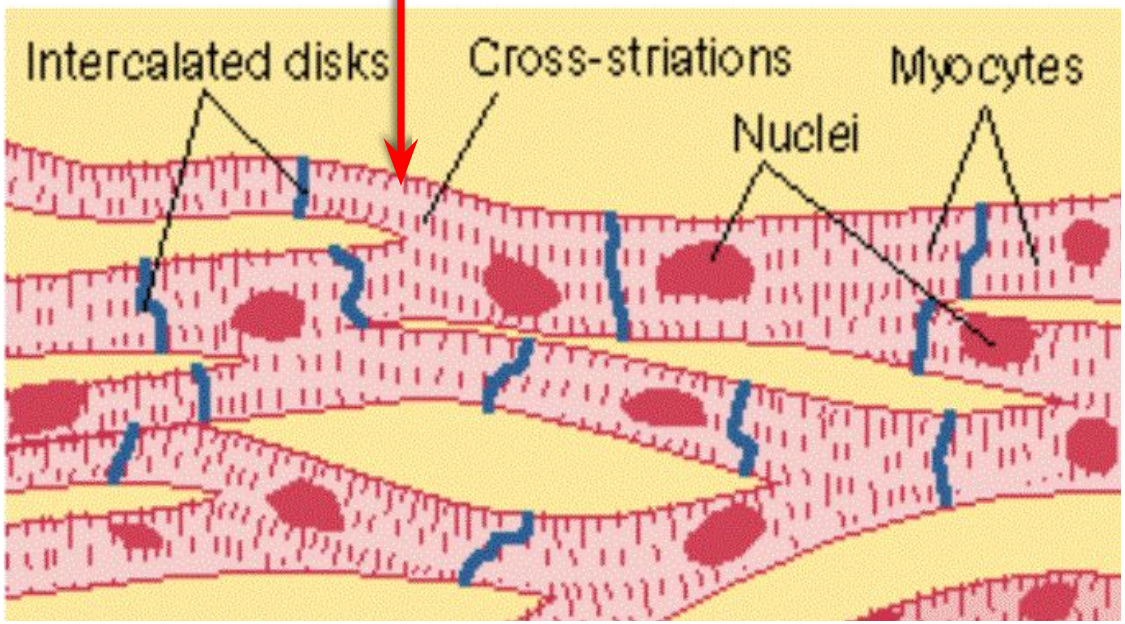
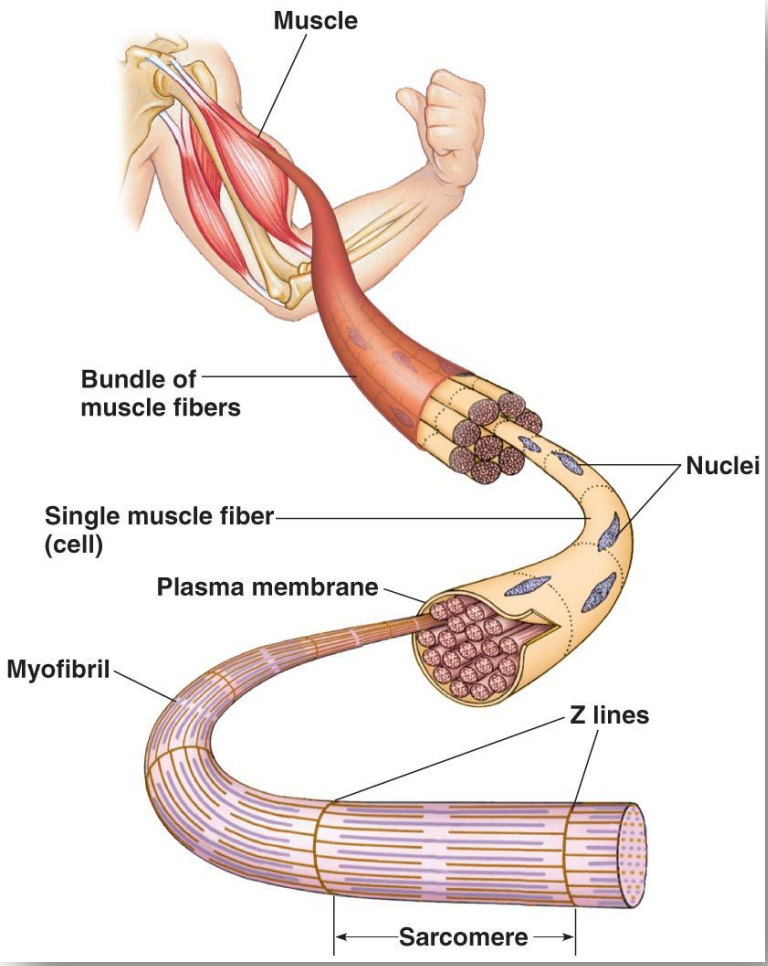
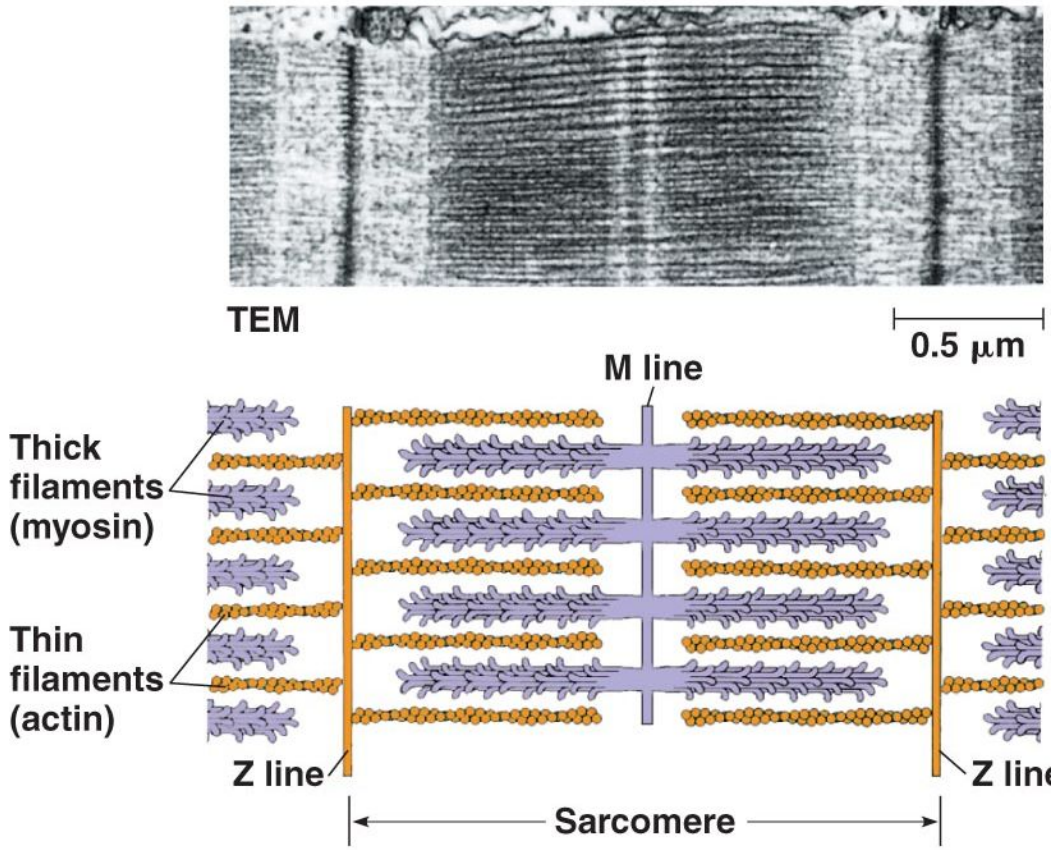



Intercalated disks
Cross-striations
Myocytes
Nuclei

Muscular contraction

- Muscle cells' membrane is called as **sarcolemma**
- Muscle cells' cytoplasm is called as **sarcoplasm**
- The contraction unit of myofibrils is called **sarcomere**
- Sarcomere contracts and relaxes by the help of proteins **actin** and **myozin**
- Actin and myozin proteins slide on each other by the help **ATP energy and Ca^{2+}**

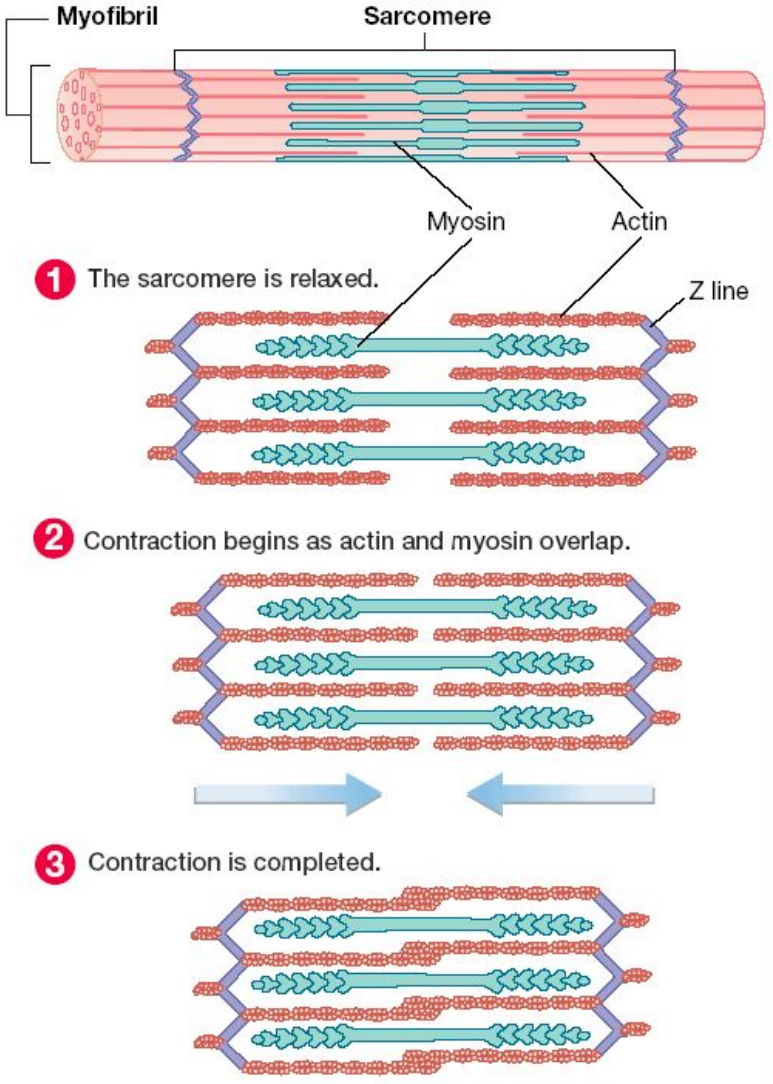

Muscle
Bundle of muscle fibers
Nuclei
Single muscle fiber (cell)
Plasma membrane
Myofibril
Z lines
Sarcomere


TEM
0.5 μm
M line
Thick filaments (myosin)
Thin filaments (actin)
Z line
Z line
Sarcomere

BIO graphic

Muscle Contraction

During a muscle contraction, sarcomeres in myofibrils shorten.



Energy Supply For Muscles

- The energy reserve in the muscles can only supply energy for 5 seconds.
- During contraction, CREATIN PHOSPHATE (which supplies 20 times more energy than ATP) is used as the primary energy source. Then ATP is used as the secondary energy source.
- Only ATP is used during relaxation.