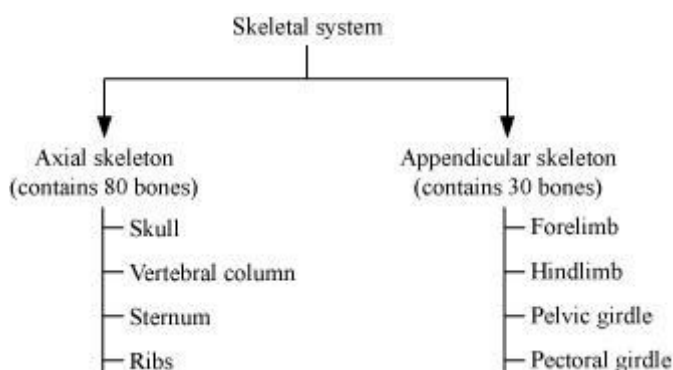


14. Human Skeleton and Locomotion

Skeletal system

- Human skeletal system is made up of 206 bones.
- A typical bone consists of osteocytes or bone cells that are embedded in a ground matrix made up of collagen fibres and calcium and phosphorus salts.



- Vertebral column forms the axis of skeleton.
- It comprises a series of 26 vertebrae.
- Vertebral formula - Bones of vertebral column starting from skull is $C_7T_{12}L_5S_1Co_1$.
- Atlas (articulate with occipital condyles) and Axis are the 1st and 2nd vertebrae respectively.
- Sternum is a flat bone on the ventral midline of thorax.
- Ribs (12 pairs) are flat bones attached dorsally to vertebral column and ventrally to sternum.
- True ribs – Upper seven pairs
- False ribs – 8th, 9th, and 10th pair; as they are not attached to the sternum directly
- Floating ribs – 11th and 12th (last two pairs); as they are not attached ventrally



Bones of forelimbs (in both forelimbs)

Humerus -2
Radius and ulna -4
Carpals (wrist bone) - 16
Metacarpals (palm bones) - 10
Phalanges (Digits) - 28

Bones of hind limbs (in both hind limbs)

Femur – 2
Tibia and fibula – 4
Tarsals (ankle bones) - 14
Metatarsals - 10
Phalanges - 28
Patella (knee cap) - 2

- Pectoral and pelvic girdle helps in articulation of forelimbs and hind limbs with axial skeleton.

Bones of pelvic girdle

— Clavicle
— Scapula

Bones of pectoral girdle

— Ilium
— Ischium
— Pubis

Joints

- Fibrous – Do not allow any movement

Example: between cranial bones

- Cartilaginous joints – Bones joint together with the help of cartilage

Example: joint between adjacent vertebrae

- Synovial joint – Have fluid-filled synovial cavity

It is of five types:

- Ball and socket joint – Example: between humerus and pectoral girdle, femur and acetabulum
- Hinge joint – Example: knee joint
- Pivot joint – Example: between atlas and axis
- Gliding joint – Example: between carpals
- Saddle joint – Example: between carpal and metacarpal of thumb

Disorders

- **Myasthenia gravis** – Autoimmune disease that affects the neuromuscular junction
- **Muscular dystrophy** – Genetic disorder that leads to weakening of skeletal muscles
- **Tetany** – Associated with painful and involuntary contraction due to low calcium ions in body fluids



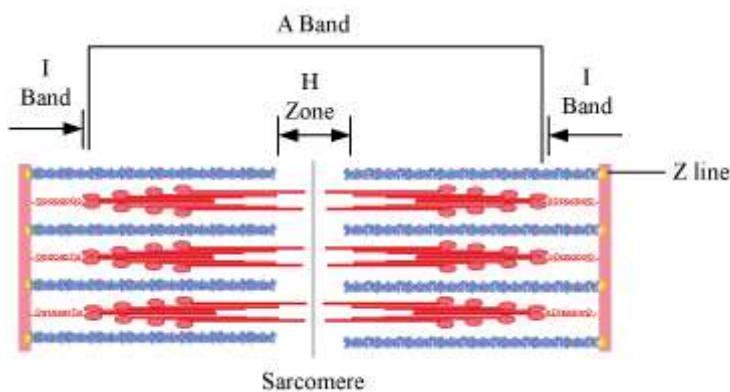
- **Arthritis** – Degenerative joint disease that occurs due to inflammation of joints
- **Osteoporosis** – Abnormal loss of bony tissue resulting into fragile porous bone
- **Gout** – Accumulation of uric acid crystal that leads to inflammation of joints
- **Joints** - These are points or places of articulation of bones. They give a framework to the skeleton.
- Study of joints - Arthrology
- Bones are attached with each other through ligaments.
- Three types of joints:
 - Synarthrosis/fixed/fibrous joints
 - Amphiarthrosis/cartilaginous/slightly movable joints
 - Diarthrosis/synovial/freely movable joints
- **Synarthrosis** - It is an immovable joint where bones are united by white fibrous connective tissues. Different types of synarthrosis joints found in our body are:
 1. Sutures of skull - Joints are serrated; hence, these sutures are also called serrate sutures.
 2. Syndesmosis - It is a joint containing a fibrous connective tissue connecting two bones such as fibula and tibia.
 3. Gomphosis - It is a joint between the teeth and the jaw bone.
- **Amphiarthrosis** - This type of joint is considered to be more developed than synarthrosis but less developed than diarthrosis. It can partially move under compression or force applied due to a twist or tension.
- The following types of partially movable joints are found in our body:
 1. Synchrondroses - Bones are connected at these joints by hyaline cartilage. These joints provide a site for the lengthening of bones in children. The epiphyseal plate present between the diaphysis and epiphysis of long bones in children is an example of synchrondroses.
 2. Symphysis - Bones are connected at this joint by fibrous cartilage. It is present between the two pubic bones of the pelvic girdle.
 3. Intervertebral joints - These joints are present between adjacent vertebrae. They are fibrocartilaginous in nature. They make the vertebral column flexible and act as shock absorbers.
- **Diarthrosis/synovial joint** - It is a perfect joint that allows maximum degree of movement. The joint is protected by synovial membrane, which secretes synovial fluid. The fluid reduces friction between two moving bones. The hyaline cartilage covers the ends of bones at a synovial joint and reduces friction.
- The following are the kinds of diarthrosis joints found in our body:
 1. Ball and socket joint - It allows 360° movement of articulated bones, i.e., rotational movement and multiaxial movements.
 2. Hinge joint - It allows uniaxial movement (only 180°).
 3. Gliding joint - It allows gliding/sliding movements.
 4. Condylloid joint - It allows biaxial movement but not rotation. Examples include metacarpophalangeal joints and radius carpal.
 5. Saddle joint - The articulating surfaces of bones at this joint are saddle-shaped; hence, it is called a saddle joint. It allows biaxial movement.
 6. Pivot joint - It allows uniaxial movement (rotation). The articulating surfaces of bones contain an odontoid process surrounded by an osteo-ligamentous ring.
- The cells of human body exhibit amoeboid, ciliary, and muscular types of movements.



- Amoeboid movement – Example: leucocytes present in the blood
- Ciliary movement – Example: passage of ova through fallopian tube
- Muscular movement – Example: movement of limbs, jaws, and tongue

Muscle

- Based on location, muscles are of three types;
 - Skeletal muscles/striated muscles – Voluntary in nature
 - Visceral muscles/smooth muscles – Involuntary in nature
 - Cardiac muscles – Involuntary in nature
- Myofibril is one of the several contractile filaments that make up a striated muscle fibre.
- Sarcomere is a part of myofibril.
- Sarcomere composed of two contractile proteins:
 - Actin – Thin filament and called I band
 - Myosin – Thick filament and called A band
- Z line bisects the centre of each I band.
- The functional unit of contraction between two successive Z lines is known as sarcomere.



- Troponin and tropomyosin are complex regulatory proteins that form a part of an actin filament.
- Troponin is attached to protein tropomyosin and masks the active binding sites for myosin on resting actin filament.
- Each myosin filament is made up of many monomeric protein called meromyosins.
- Meromyosin is made up of light meromyosin and heavy meromyosin. They help in cross bridge formation.

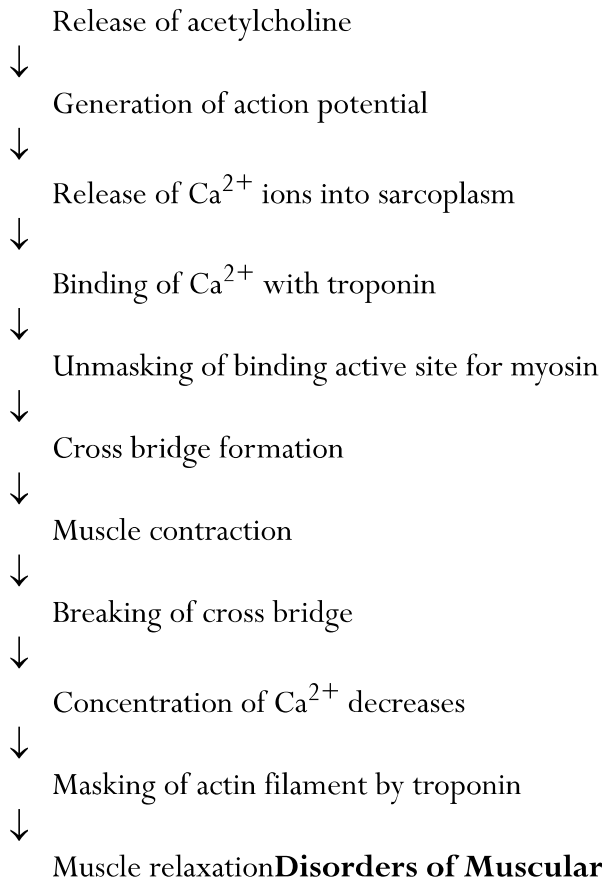
- Based on myoglobin, two types of muscle fibres are present:

- Red muscle fibres** contain an abundance of myoglobin. Lots of mitochondria are present in red muscle fibres.
 - White muscle fibres** contain less amount of myoglobin. Less number of mitochondria is present in white muscle fibres.
- Sliding filament theory**

- It states that during the process of muscle contraction, the thin filaments slide over the thick filaments.
- During muscle contraction:

- The distance between adjacent Z-lines decreases.
- I band gets reduced while A band retains its original length.
- H-zone gets reduced.
- The size of sarcomere decreases.

- Steps of muscle contraction and relaxation:



Disorders of Muscular and Skeletal system

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