Skeletal system

Bone

- Bones are rigid organs that form part of the endoskeleton of vertebrates.
- They function to move, support, and protect the various organs of the body, produce red and white blood cells, and store minerals.
- Bone tissue is a type of dense connective tissue. Bones come in a variety of shapes and sizes and have a complex internal and external structure.

Composition and Properties of Bone

1. Matrix Material:

A. **Organic Components**: Primarily collagen, which provides tensile strength and flexibility.

B. **Inorganic Components**: Primarily calcium phosphate, which provides hardness and resistance to compression.

2. Bone Cells:

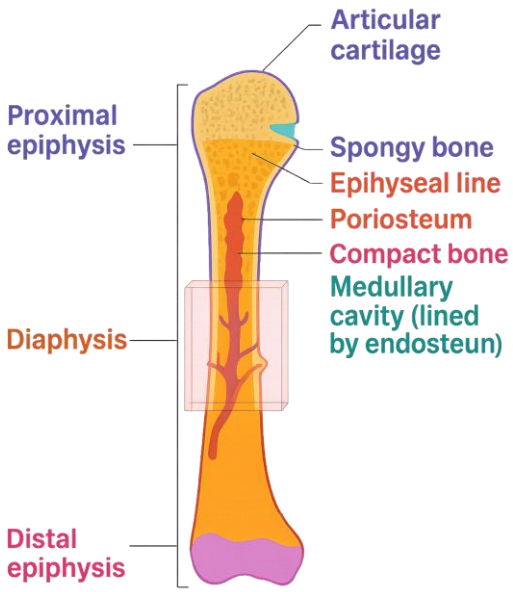
A. **Osteoblasts**: Cells responsible for bone formation.

B. **Osteocytes**: Mature bone cells that maintain the bone matrix.

C. **Osteoclasts**: Cells involved in the resorption of bone tissue.

Structure of Bone

- Bones are rigid connective tissue organs that make up the skeletal system.
- They are composed of specialized cells, extracellular matrix, and minerals.
- The structure of a bone can be divided into two parts: **the macroscopic and microscopic structures**.



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Macroscopic Structure of Bone:

1. Diaphysis:

- The long, cylindrical portion of a long bone.
- Composed primarily of compact bone, providing strength and rigidity.

2. Epiphyses:

- The rounded ends of a long bone.
- Mostly made of spongy bone, with an outer layer of compact bone.

3. Metaphysis:

- The region between the diaphysis and epiphysis where bone growth occurs during childhood and adolescence.
- Contains the epiphyseal plate (growth plate) in growing individuals.

4. Periosteum:

- A dense, fibrous membrane covering the outer surface of bones, except at joints.
- Contains blood vessels, nerves, and osteogenic cells essential for bone growth, repair, and nutrition.

5. Endosteum:

- A thin, vascular membrane lining the inner surface of bones, including the medullary cavity and trabeculae of spongy bone.
- Contains osteogenic cells involved in bone growth and repair.

6. Medullary Cavity:

- A hollow space within the diaphysis of long bones.
- Filled with yellow bone marrow, which stores fat and serves as an energy reserve.

Microscopic Structure of Bone:

1. Compact Bone:

- Also known as cortical bone, it is dense and forms the outer layer of bones.
- Consists of tightly packed concentric rings called lamellae, surrounding a central Haversian canal.
- Haversian canals contain blood vessels and nerves, providing nutrients and oxygen to the bone cells.

2. Spongy Bone:

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- Also known as cancellous or trabecular bone, found mainly in the epiphyses of long bones and the interior of other bones.
- Consists of a network of interconnected trabeculae, creating a porous structure.
- The spaces within spongy bone are filled with red bone marrow, where blood cell production occurs.

Functions:

1. **Support:** Bones provide a framework for the attachment of muscles and other tissues.
2. **Protection:** Bones such as the skull and rib cage protect vital organs from injury.
3. **Movement:** Muscles are attached to bones, which act as levers to produce movement.
4. **Mineral Storage:** Bones serve as a reservoir for minerals, particularly calcium and phosphorus.
5. **Blood Cell Production:** The marrow in the cavities of bones is the site of red blood cell production (haematopoiesis).

Bone Growth and Remodelling:

1. Growth:

- Bones grow in length due to activity at the epiphyseal plate (growth plate).
- Bones grow in diameter through the addition of bone tissue at the surface.

2. Remodeling:

- A lifelong process where bone tissue is continuously replaced and reshaped.
- Influenced by mechanical stress and hormonal changes.

Types of Bones

1. Long Bones:

- Longer than they are wide, functioning as levers for movement.
    - **Examples**: Femur, tibia, fibula, humerus, radius, ulna.

2. Short Bones:

- Cube-shaped, providing support and stability with little movement.
    - **Examples**: Carpals (wrist bones), tarsals (ankle bones).

3. Flat Bones:

- Thin, flattened shape, protecting underlying organs or providing large surface areas for muscle attachment.
    - **Examples**: Skull bones, scapula, sternum, ribs.

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4. Irregular Bones:

- Complex shapes that fulfill various functions, such as protection and support.
    - **Examples**: Vertebrae, sacrum, coccyx, bones of the pelvis (ilium, ischium, pubis).

5. Sesamoid Bones:

- Small, round bones embedded within tendons, helping to reduce friction.
    - **Example**: Patella (kneecap).

Health and Disease of Bones

1. Osteoporosis:

- A condition characterized by decreased bone mass and increased susceptibility to fractures.

2. Arthritis:

- Inflammation of the joints, which can affect the surrounding bone structure.

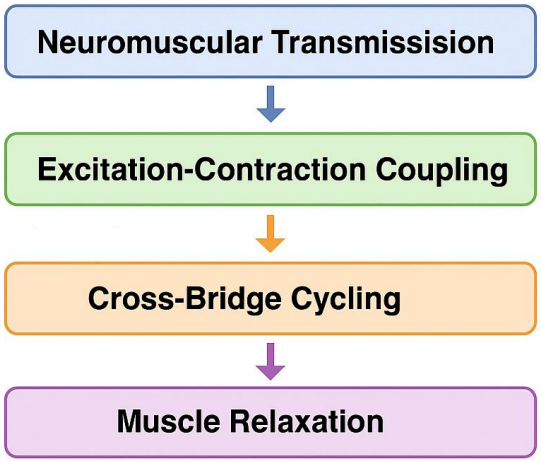
3. Fractures:

- Breaks in the bone often caused by stress or impact.

Physiology of muscle contraction

- Muscle contraction is a multi-step process involving the interaction of actin and myosin filaments within muscle fibers.

It occurs in four key stages:



1. Neuromuscular Transmission

- **Action Potential Initiation:** A nerve impulse begins in a motor neuron.

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