Anatomy of The Musculoskeletal System

Dr. Nabil Khouri MD, MSc, Ph.D
What we will study!
The Muscular and Skeletal system

The Musculo-Skeletal system:

is made of **Bones, muscles and Joints**

*Bone:* is a hard supporting *Tissue*

make up the skeleton

Found in many forms including:

“small, large, long, short and flat”

Bones are held together by *Joints*

which allow and/or restrict movements.

Movements are performed by the action of the *Muscles* upon their contractions

Muscle is made of muscular tissue
Bones tissue

Two *bone tissue* Forms

- **Compact bone tissue**
  - Is made up of concentric rings of matrix that surround central canals which contain blood vessels.
  - Embedded in this bone tissue are small cave-like spaces called lacunae, which are connected to each other through small tunnels called canalicula.
  - The lacunae contain osteocytes cells. As just discussed, osteocytes help maintain healthy bone tissue and are involved in the bone remodeling process that will be outlined later in this lesson.

- **Spongy bone tissue**
  - Looks like an irregular latticeshaped (or sponge) spaces.
  - Spaces are filled with red bone marrow which is the site of Hemopoiesis or formation of blood cells.
Video
Characteristics of muscular tissue:

- **Excitability**
  - Tissue can receive & respond to stimulation

- **Contractility**
  - Tissue can shorten & thicken

- **Extensibility**
  - Tissue can lengthen

- **Elasticity**
  - After contracting or lengthening, tissue always wants to return to its resting state
Types of Ordinary Body Movements

- Flexion – decreases angle of joint and brings two bones closer together
- Extension - opposite of flexion
- Abduction/Adduction.
- Rotation - movement of a bone in longitudinal axis, shaking head “no”
- Circumduction
Body Movements

(a) Flexion and extension of the shoulder and knee

(b) Flexion, extension, and hyperextension

(c) Rotation

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Abduction – moving the leg away from the midline

Adduction – moving toward the midline

Circumduction: cone-shaped movement, proximal end doesn’t move, while distal end moves in a circle.
Objectives

- Divisions of the Skeleton
- Classification of Bones
- Major bony landmarks
Bones: Forms the skeleton and are arranged into Axial and appendicular groups

- **Axial skeleton**
  - Vertebral Column 26
  - Skull 22
  - Hyoid bone 1
  - Ribs and sternum 25

- **Appendiculular skeleton**
  - Upper Extremities 64
  - Lower Extremities 62

- Auditory bones 6

- The total number of bones 206
Divisions of the Skeleton

The Axial skeleton
- The skull
- The sternum
- The ribs
- The vertebral column

The appendicular skeleton
- Upper extremities
- Lower extremities
- The shoulder girdle
- The pelvic girdle
Function of Bones

- support (eg: pelvis, legs)
- protect (eg: skull, vertebrae)
- mineral storage (eg: calcium, phosphate, inorganic component)
- movement (eg: walk, grasp objects)
- blood-cell formation (eg: red bone marrow)

Cellular components include
- Osteoblasts: secrete organic part of bone matrix = osteoid
- Osteocytes: mature bone cells, maintain bone matrix


Classification of Bones

**Types of Bone**

1). Long bones
2). Short bones.
3). Flat bone:
4). Irregular bones
5). Sesamoid bones are special short bones: Ex: patella
Long bone
(femur or thighbone)

Irregular bone
(sphenoid bone from skull)

Short bone
(carpal or wrist bone)

Flat bone
(parietal bone from roof of skull)
Long Bones

- **Long bones** are characterized by having one shaft (the **Diaphysis**) that is much greater in length than width and two extremities (epiphysis).
- They are comprised mostly of **compact bone** and lesser amounts of **marrow**, which is located within the **medullary cavity**, and **spongy bone**.
- Most bones of the limbs, including those of the **fingers** and **toes**, are long bones.
Short bones

- **Short bones**
  Cube-shaped bones of the wrist and ankle

- **sesamoid bones**
  Bones that form within tendons (e.g., patella)
Flat bones

- Thin, flattened, and a bit curved (e.g., sternum, and most skull bones)
Irregular bones

- bones with complicated shapes
- (e.g., vertebrae and hip bones)
Surface Features of the Bone

1). Projections that form joints
   a). **Head**: Usually proximal, Could refer to as the articular end of the bone
   b). **Facet**: A small, flattened surface (articular)
   c). **Condyle**: A large, Rounded projection, often articulates with a corresponding fossa
   d). **Ramus**: An arm-like branch off the body of a bone
Surface Features of the Bone

2). Sites of muscle & ligament attachment.
   a). Tuberosity: Is a projection or bump with a roughened surface
   b). Crest: A prominent elevation or ridge
   c). Spine: A relatively long, thin projection or bone protrusion.
   d). Trochanter: A specific tuberosities located on specific bones “Femur”
   e). Tubercle: A projection or elevation with a roughened surface, generally smaller than a tuberosity.
   f). Line
   g). Epicondyle: A projection near to a condyle usually not part of the joint.
   h). Process: A relatively large projection or prominent bone expansion
3). **Openings that allow blood vessels and nerves to pass**
   - a). **Meatus**: A short canal
   - b). **Fissure**: Is a narrow slit like opening that is usually found between two bones
   - c). **Foramen**: An opening through a bone with different forms.
   - d). **Canal**: A long, tunnel-like foramen (canal), usually a passage for notable nerves or blood vessels
   - e). **Sinus**: Pocket (or a cavity) like structure within the a bone (especially cranial bones)
Surface Features of the Bone

4). Depressions

- a). **Fossa:** A broad, shallow depressed area
- b). **Grove:** Furrow
- c). **Notch:** A small depression Indentation at the edge of a structure
## 3. Other Skeletal Conditions (and their causes and effects)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Cause</th>
<th>Effect</th>
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| Arthritis                        | Over 200 diseases have been said to possibly lead to arthritis, including:  
- osteoarthritis             | Swelling, warmth, redness of the overlying skin, pain, restriction of motion.                                       |
| Inflammation of one or more joints |  
- rheumatoid arthritis       |                                                                                                                  |
|                                  | - gout                                                               |                                                                                                                  |
|                                  | - tuberculosis, and other infections                                 |                                                                                                                  |
| Osteo Arthritis                  | Osteo-arthritis is due to wear of the articulatory cartilage and can lead to secondary changes in the underlying bone.  
It can be primary or occur secondarily to abnormal load to the joint or damage to the cartilage from inflammation or trauma. | The joints are painful and stiff with restricted movement. Osteoarthritis is recognized on X-ray by narrowing of the joint space (due to loss of cartilage) and the presence of osteophytes, osteosclerosis, and cysts in the bone. |
| Degenerative joint disease       |                                                                                                                  |                                                                                                                  |
| Rheumatoid Arthritis             | Rheumatoid Arthritis is a disease of the synovial lining of joints: The joints are initially painful, swollen, and stiff and are usually affected symmetrically.  
Onset can be at any age, and these is considerable risk of severity. Women are at greater risk. Rheumatoid arthritis is an autoimmune disease, and most patients show presence of rheumatoid factor in their serum*. | As the disease progresses the ligaments supporting the joints are damaged and there is erosion of the bone, leading to deformity of the joints. Tendon sheaths can be affected, leading to tendon rupture. |
<table>
<thead>
<tr>
<th>Disease</th>
<th>Description</th>
<th>Example</th>
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<tbody>
<tr>
<td>Bone Cancer</td>
<td>Bone cancer can occur as a secondary cancer from, for example, prostate cancer.</td>
<td>Damage to stem cells (the cause of leukaemia).</td>
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<tr>
<td>Gout</td>
<td>Gout is caused by a defect in uric acid balance in the metabolism resulting in an excess of the acid and its salts (urates) which then accumulate in the bloodstream and joints, respectively.</td>
<td>Gout can result in attacks of acute gouty arthritis, chronic destruction of the joints, and deposits of urates (tophi) in the skin and cartilage - especially of the ears. The excess urates can also damage the kidneys in which stones might form.</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>Infection, injury and synovitis can cause localized osteoporosis of adjacent bone. Generalised osteoporosis is common in the elderly and can follow menopause (women). It is also a feature of Cushing's disease and prolonged steroid therapy.</td>
<td>Bones that are brittle and liable to fracture.</td>
</tr>
<tr>
<td>Rickets</td>
<td>Rickets is a childhood condition caused by insufficient vitamin D and Calcium.</td>
<td>Bow legs.</td>
</tr>
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<td>Loss of bone tissue</td>
<td></td>
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The Axial Skeleton

Eighty bones segregated into three regions
- Skull
- Vertebral column
- Bony thorax
The skull, the body’s most complex bony structure, is formed by the cranium and facial bones.

- **Cranium** –
  - protects the brain and is the site of attachment for head and neck muscles

- **Facial bones**
  - Supply the framework of the face, the sense organs, and the teeth
  - Provide openings for the passage of air and food
  - Anchor the facial muscles of expression
Anatomy of the Cranium

- Eight cranial bones –
  - Two parietal
  - Two temporal
  - One frontal.
  - One occipital
  - One sphenoid
  - One ethmoid

- Cranial bones are thin **flat** bones.
- remarkably strong for their weight
Developmental Aspects of the Skeleton: Fetal Skull

(a) Superior view

(b) Lateral view
Skull Sutures

- Four sutures mark the articulations of the parietal bones
  - **Coronal suture** – articulation between parietal bones and frontal bone anteriorly
  - **Sagittal suture** – where right and left parietal bones meet superiorly
  - **Lambdoid suture** – where parietal bones meet the occipital bone posteriorly
  - **Squamous suture** – where parietal and temporal bones meet
Frontal Bone

- Forms the anterior portion of the cranium
- Articulates posterior with the parietal bones via the coronal suture
- Major markings include the supra-orbital margins, the anterior cranial fossa, and the frontal sinuses (internal and lateral to the glabella)
Parietal Bones: lateral aspects of the skull

- Coronal suture
- Frontal bone
- Sphenoid bone (greater wing)
- Ethmoid bone
- Lacrimal bone
- Lacrimal fossa
- Nasal bone
- Zygomatic bone
- Maxilla
- Alveolar margins
- Mandible
- Mental foramen
- Coronoid process

(a) External anatomy of the right side of the skull
Occipital Bone: Posterior view of the skull

Forms most of skull’s posterior wall and base
Major markings include the posterior cranial fossa, foramen magnum, occipital condyles, and the hypoglossal canal
Occipital Bone and Its Major Markings

- Olfactory foramina
- Anterior cranial fossa
- Sphenoid ( Lesser wing, Greater wing)
- Sella turcica (Tuberculum sellae, Hypophyseal fossa, Dorsum sellae, Posterior clinoid process)
- Middle cranial fossa
- Temporal bone (petrous portion)
- Internal acoustic meatus
- Posterior cranial fossa
- Parietal bone
- Occipital bone
- Frontal bone
- Cribiform plate
- Crista galli
- Ethmoid bone
- Optic canal
- Anterior clinoid process
- Foramen rotundum
- Foramen ovale
- Foramen spinosum
- Foramen lacerum
- Jugular foramen
- Hypoglossal canal
- Foramen magnum
Temporal Bones

- Form the inferolateral aspects of the skull and parts of the cranial floor
- Divided into four major regions – squamous, tympanic, mastoid, and petrous
Med-lateral Aspects of the Skull

- Parietal bone
- Squamous suture
- Temporal bone
- Lambdoid suture
- Occipital bone
- Occipitomastoid suture
- External occipital protuberance
- Internal acoustic meatus
- Sella turcica
- Pterygoid process
- Mandibular foramen
- Palatine bone
- Mandible
- Coronal suture
- Frontal bone
- Sphenoid bone (greater wing)
- Frontal sinus
- Crista galli
- Nasal bone
- Sphenoid sinus
- Ethmoid bone (perpendicular plate)
- Vomer bone
- Incisive canal
- Maxilla
- Alveolar margins

Petros part of Temporal bone
Inferior Aspect of the Skull base

- Maxilla (palatine process)
- Hard palate
- Palatine bone (horizontal plate)
- Zygomatic bone
- Temporal bone (zygomatic process)
- Vomer
- Mandibular fossa
- Styloid process
- Mastoid process
- Temporal bone (petrous portion)
- Pharyngeal tubercle
- Parietal bone
- External occipital crest
- External occipital protuberance
- Incisive fossa
- Medial palatine suture
- Infraorbital foramen
- Maxilla
- Sphenoid bone (greater wing)
- Foramen ovale
- Foramen lacerum
- Carotid canal
- External auditory meatus
- Stylomastoid foramen
- Jugular foramen
- Occipital condyle
- Inferior nuchal line
- Superior nuchal line
- Foramen magnum
Superior view of the skull base

- Olfactory foramina
- Anterior cranial fossa
- Sphenoid: Lesser wing, Greater wing
- Sella turcica: Tuberculum sellae, Hypophyseal fossa, Dorsum sellae, Posterior clinoid process
- Middle cranial fossa
- Temporal bone (petrous portion)
- Internal acoustic meatus
- Posterior cranial fossa
- Parietal bone
- Occipital bone
- Frontal bone
- Cribiform plate
- Cribriform plate
- Crista galli
- Ethmoid bone
- Optic canal
- Anterior clinoid process
- Foramen rotundum
- Foramen ovale
- Foramen spinosum
- Foramen lacerum
- Jugular foramen
- Hypoglossal canal
- Foramen magnum
Sphenoid Bone

- Butterfly-shaped bone that spans the width of the middle cranial fossa
- Forms the central wedge that articulates with all other cranial bones
- Consists of a central body, greater wings, lesser wings, and pterygoid processes
- Major markings: the sella turcica, hypophyseal fossa, and the pterygoid processes
- Major openings include the foramina rotundum, ovale, and spinosum; the optic canals; and the superior orbital fissure
Sphenoid Bone

(a) Superior view

- Greater wing
- Hypophyseal fossa of sella turcica
- Optic canal
- Chiasmatic groove
- Lesser wing
- Anterior clinoid process
- Foramen rotundum
- Foramen ovale
- Foramen spinosum
- Dorsum sellae
- Body of sphenoid

(b) Posterior view

- Body of sphenoid
- Posterior clinoid process
- Superior orbital fissure
- Foramen rotundum
- Pterygoid process
- Pterygoid plates
Ethmoid Bone

- Most deep of the skull bones; lies between the sphenoid and nasal bones
- Forms most of the bony area between the nasal cavity and the orbits
- Major markings include the cribriform plate, crista galli, perpendicular plate, nasal conchae, and the ethmoid sinuses
Ethmoid Bone

- Olfactory foramina
- Crista galli
- Cribriform plate (part of horizontal plate)
- Orbital plate
- Ethmoid sinuses
- Perpendicular plate
- Middle nasal concha
- Left lateral mass
Facial Bones

- Fourteen bones of which only the mandible and vomer are unpaired

The paired bones are:

- Maxillae
- Zygomatics
- Nasals
- Lacrimals
- Palatines
- Inferior conchae
- Mandible
- Vomer
Maxillary Bones

Medially fused bones that make up the upper jaw and the central portion of the facial skeleton

- Facial keystone bones that articulate with all other facial bones, except the mandible
- Their major markings include palatine, frontal, and zygomatic processes, the alveolar margins, inferior orbital fissure, and the maxillary sinuses
Maxillary Bones

- Frontal process
- Orbital surface
- Zygomatic process
- Maxillary bone
- Infraorbital foramen
- Anterior nasal spine
- Alveolar margin

(b) Maxilla
Zygomatic Bones

- Irregularly shaped bones (cheekbones) that form the prominences of the cheeks and the inferolateral margins of the orbits.
Other Facial Bones

**Nasal bones** – thin medially fused two bones that form the bridge of the nose

**Lacrimal bones** – contribute to the medial walls of the orbit and contain a deep groove called the lacrimal fossa that houses the lacrimal sac

**Palatine bones** – two bone plates that form portions of the hard palate, the posterolateral walls of the nasal cavity, and a small part of the orbits
Palatine bone

**Fig. 393.** The right palatine bone. Posterior aspect.

- Air sinus on sphenoidal aspect
- Orbital surface
- Orbital process
- Lateral surface
- Sphenoidal process
- Perpendicular plate
- Conchal crest
- Greater palatine groove (upper end)
- Horizontal part
- Articulates with lateral pterygoid plate
- Articulates with medial pterygoid plate
- Tubercle
- Medial pterygoid m.
Other Facial Bones

- **Vomer** – plow-shaped bone that forms part of the nasal septum
- **Inferior nasal conchae** – paired, curved bones in the nasal cavity that form part of the lateral walls of the nasal cavity
The Orbit

- Bony cavities in which the eyes are firmly encased and cushioned by fatty tissue
- Formed by parts of **seven bones** – frontal, sphenoid, zygomatic, maxilla, palatine, lacrimal, and ethmoid
The Orbit

Figure 7.9b

- **Roof of orbit**
  - Lesser wing of sphenoid bone
  - Orbital plate of frontal bone

- **Lateral wall of orbit**
  - Inferior extension of frontal bone
  - Greater wing of sphenoid bone
  - Orbital surface of zygomatic bone

- **Medial wall**
  - Sphenoid body
  - Orbital plate of ethmoid bone
  - Frontal process of maxilla
  - Lacrimal bone

- **Floor of orbit**
  - Orbital process of palatine bone
  - Orbital surface of maxillary bone
  - Zygomatic bone

- **Structures**
  - Supraorbital foramen
  - Superior orbital fissure
  - Optic canal

- **Nasal bone**

(b)
Nasal Cavity

- Constructed of bone and hyaline cartilage
- Roof – formed by the cribriform plate of the ethmoid
- Lateral walls – formed by the superior and middle conchae of the ethmoid, the perpendicular plate of the palatine, and the inferior nasal conchae
- Floor – formed by palatine process of the maxillae and palatine bone
Nasal Cavity lateral wall

- Frontal sinus
- Superior nasal concha
- Middle nasal concha
- Inferior nasal concha
- Ethmoid bone
- Nasal bone
- Maxillary bone (palatine process)
- Sphenoid bone
- Sphenoid sinus
- Pterygoid process
- Palatine bone (perpendicular plate)
- Palatine bone (horizontal plate)
Sinuses connections and drainage

- Opening of middle ethmoidal cells onto bulla ethmoidalis
- Opening to posterior ethmoidal cells into lateral wall of superior meatus
- Opening of sphenoidal sinus into sphenoid-ethmoidal recess
- Hiatus semilunar
- Opening of nasolacrimal duct
- Opening of maxillary sinus in floor of sphenoid-ethmoidal recess

Infundibulum opening of frontonasal duct that drains the frontal sinus and anterior ethmoid cells
Medial wall of the nasal cavity
Floor of the Nasal cavity

The Hard Palate: Bones

The **hard palate** is formed by the **palatine processes of the maxillae** and the **horizontal plates of the palatine bones**.
posterior
nasal aperture
Para-nasal Sinuses

- Mucosa-lined, air-filled sacs found in five skull bones – the frontal, sphenoid, ethmoid, and paired maxillary bones
- Air enters the paranasal sinuses from the nasal cavity and mucus drains into the nasal cavity from the sinuses
- Lighten the skull and enhance the resonance of the voice
Paranasal Sinuses

- Sphenoid sinus
- Frontal sinus
- Ethmoid sinus
- Maxillary sinus
Mandible Bone

- The mandible (lower jawbone) is the largest, strongest bone of the face.
- Its major markings include the coronoid process, mandibular condyle, the alveolar margin, and the mandibular and mental foramina.
Hyoid Bone

- Not actually part of the skull, but lies just inferior to the mandible in the anterior neck
- Only bone of the body that does not articulate directly with another bone
- Attachment point for neck muscles that raise and lower the larynx during swallowing and speech