

Skeletal System Bones and Markings

CRANIUM OR SKULL (8)

Frontal (1) – includes area of forehead, roof of nasal cavity, roof of eye sockets

- **Supraorbital foramen** – blood vessels and nerves pass to tissues of the forehead
- **Frontal sinuses** – above e/ eye near midline
- Frontal bone is a single bone as adult: two bones as infant – fuse 5-6 yrs.

Parietal (2) - on e/ side of skull behind frontal bone. Form bulging sides & roof of cranium.

- **Sagittal suture** – fuse at midline
- **Coronal suture** – Parietal and frontal bones meet

Temporal (2) – on e/ side of skull joined by parietal bone

- **Squamosal suture** – connects temporal and parietal bones
- **External auditory meatus** – located near inferior margin, leads inward to parts of the ear – tube like depression
- **Mandibular fossa** – fossa (deep pit or depression) also called glenoid fossa – articulates w/ mandibular condyle
- **Styloid process** – long & pointed. Anchors muscles associated w/ tongue & pharynx
- **Carotid canal** – beside styloid process – internal carotid artery
- **Jugular foramen** – larger, under carotid canal
- **Zygomatic process** – 2 parts – projects anteriorly from temporal bone near external aud. meatus – joins the zygomatic bone and helps form cheek
- **Mastoid process** – prominent projection behind ear. Attachment for muscles of the neck. Area often inflamed in children that are put to bed with a bottle.

Occipital (1) – back of the skull & base of cranium

- **Lambdoidal suture** - joins occipital, temporal & parietal.
- **Foramen magnum** – large opening houses nerve fibers from the brain that pass through & enter vertebral canal to become part of spinal cord
- **Occipital condyle** – rounded process on e/ side of foramen magnum that articulates with the atlas

Sphenoid bone (1) – two winglike structures (greater & lesser wings) that are found wedged b/t several other bones in the anterior portion of the cranium. Looks like a butterfly or bat. Forms base of cranium, sides of skull & floors and sides of orbits

- **Sella turcica** – saddle shaped – pituitary gland fits into it which hangs from base of the brain by a stalk
- **Greater & lesser wings**
First three foramen form sort of a line starting anteriorly w/ rotunda beside sella turcica. Look medially from spinosum and see foramen lacernum (**fig. 7.26 best**)
- **Foramen rotundum** -cranial nerves and blood vessels – maxillary division of nerves
- **Foramen ovale** -cranial nerves and blood vessels – mandibular veins and nerves
- ***Foramum spinosum** – cranial nerves & blood vessels – tiny on edge of greater wind
- **Foramen lacernum** -cranial nerves and blood vessels – branch of pharyngeal artery

Ethmoid bone (1) – front of sphenoid bone (floor of cranial cavity looking from above). Two masses – one on e/ side of nasal cavity. Orbit area behind lacrymal bone.

- **Cribriform plate** – horizontal plate that joins two masses of ethmoid bone. These plates form part of the roof of the nasal cavity and nerves assoc. w/ smell pass through tiny openings called olfactory foramina)
- **Crista galli** – projects upward into cranial cavity – triangular process. Membranes that enclose the brain attach to this process
- ***Perpendicular plate** – projects downward in the midline to form most of the nasal septum
- ***Superior & middle nasal concha** – delicate scroll shaped plates project inward from ethmoid bone towards perpendicular plate. Support mucous membranes that line nasal cavity
- ***Ethmoid sinuses** – many small air spaces on lateral portions of ethmoid bone

FACIAL SKELETON (13 IMMOVABLE BONES + MANDIBLE)

Maxillary bones (2) – upper jaw. All other facial bones articulate w/ it – form keystone of the face

- **Palatine process** – roof of the mouth. During development 2 bones that fuse
- **Medial palatine suture** – where palatine processes fuse during development
- **Incisive or infraorbital foramen** – close to incisors – infraorbital blood vessels and nerves
- **Greater palatine foramen** – opening toward the back of the roof of the mouth – palatine blood vessels and nerves
- ***Maxillary sinuses** – lateral to nasal cavity. Largest sinuses

Palatine bones (2) – Soft palate. L shaped bones located behind the maxillae. Horizontal portions form posterior section of hard palate & floor of nasal cavity. Perpendicular portion help form lateral walls of nasal cavity

Zygomatic bones (2) – cheekbones.

- **Temporal process** – extends posteriorly to join zygomatic process of the temporal bone
- **Zygomatic arch** – connects Zygomatic process & temporal bone

Lacrimal bones (2) – 1st indentation (medial wall) in orbits of the eyes. B/t ethmoid bone & maxilla. contain tear ducts

Nasal bones (2) – Long, thin, rectangular. Lie side-by-side and fused at midline – bridge of the nose. Attachments for cartilaginous tissues that form the shape of the nose

Orbit – eye sockets – parts of frontal, maxillae lacrimal, ethmoid, sphenoid bones

- **Optic canal or optic foramen** – located in lesser wing of sphenoid bone – passage of optic nerve & ophthalmic artery
- **Superior orbital fissure** – lateral wall of orbit – oculomotor, trochlear, and abducens nerves, and ophthalmic division of trigeminal nerve

Vomer bone (1) – bridge of nose. Thin, flat, located along midline of nasal cavity. Posteriorly, joins perpendicular plate of ethmoid bone. Entire plate not vomer bone – just bottom part

***Inferior nasal concha (2)** – attached to the lateral wall of nasal cavity. Largest conchae and positioned below superior & middle conchae of ethmoid bone. Support mucous membranes w/in nasal cavity

Mandible (1) – lower portion of the jaw

- **Ramus** – flat portion, posterior sides of jaw
- **Mandibular condyle** – fits into mandibular fossa of temporal bones
- **Coronoid process** – provide attachments for muscles used in chewing
- **Mandibular foramen** – medial side of mandible. Blood vessels and nerves, which supply the roots of the lower teeth. Dentists inject anesthetics into this tissue to block nerve impulses
- **Mental foramen** – Branches of blood vessels and nerves emerge from the mandible through the mental foramen – opens to the outside – to nourish tissues of the chin & lower lip.

BONES OF THE VERTEBRAL COLUMN – BACKBONE

Cervical vertebrae (7) – Neck

*Smallest of vertebrae

*Densest tissue

*Transverse foramen for arteries to brain

*Spinous process – bifid

*7th vert – prominent – feel through skin

- **Atlas** – 1st vertebrae. Holds the head up.
- **Facet** that articulate with occipital condyle
- ***Fovea dentis** – facet that articulates with dens of axis
- **2 transverse processes** – possess transverse foramen –houses arteries leading to brain
- **Axis** – second cervical vert. –rotation of head side to side
- **Dens** – (odontoid process) – tooth like structure points upward I lies in the ring of the atlas
 - **Anterior articular facet** – for atlas
- ***Inferior articulating process** – cartilage covered – articulate with vertebrae below
- **Bifid spinous process** – C2 through C6 – attachment for muscles

Thoracic vertebrae (12)

*Longer than cervical vert.

*Long pointed spinous process – pointed downward

*Side facets that articulate with ribs

*T3 – body begins increasing in size

- **Spinous Process** – long pointed downward
- **2 transverse process** – no transverse foramen – **facet** on the end that articulates with rib tubercle
- **Body** – T3 body gets bigger
- **Vertebral foramen** – spinal cord passes through
- ***Intervertebral foramen** – passageway for spinal nerves – connect to spinal cord
- **Superior articulating process** – cartilage covered facets – joins to vertebrae above it
- **Inferior articulating process** – cartilage covered facets – joins to vertebrae below it
- *** Spondylolysis** – fracture between the superior & inferior articulating processes – common in gymnasts, high jumpers etc. hyperextend and rotate their vertebral column and stress them with impact

Lumbar vertebrae (5)

- *Transverse process project posteriorly at a sharp angle
- *Short thick spinous processes that are nearly horizontal
- *L2 – spinal cord ends
- *During a “spinal tap” – cerebrospinal fluid drawn from area b/t L2 and S2 – 5 vertebral area. Usually the crest of the iliac bone provides a landmark to determine the approx. center of the lumbar cistern (expanded area of the subarachnoid space)

Sacrum (5 fused vertebrae – fuse b/t 18 – 30 yrs) – a triangular shaped structure at the base of the vertebral column

- **Superior articular process** –
- **Sacral promontory** – was the body of the 1st sacral vert – MD can feel & determine size of the pelvis
- **Sacral canal** – vertebral foramen of the sacral vertebrae form the sacral canal – continues through the sacrum to the opening at the tip called the **sacral hiatus**
- **Sacral hiatus – opening** - exits b/c the laminae of the last sacral vertebra are not fused
- **Tubercle of median sacral crest** – small knoblike process formed by fusing of spinous processes
- **Sacral foramen** – passage of nerves and blood vessels
 - **Pelvic sacral foramen**
 - **Dorsal sacral foramen** –

Coccyx (4 fused vertebrae – fuse by 25th yr) – tail bone

- *Ligaments attach it to the margins of the sacral hiatus
- *Sitting presses on the coccyx and moves forward – acts like a shock absorber
- *Fracture or dislocate – falling

Ribs – (12 pairs – one to e/ thoracic vert.)

- *Long slender shaft which curves around the chest and slopes downward
- ***Posterior end** – enlarged **head** – rib articulates w/ a facet on **body** of its own vertebra and w/ body of the next higher vertebra.
- ***Neck** of rib is flattened – lateral to the head – where ligaments attach
- ***Tubercle** close to head – articulates w/ transverse process of the vertebra
- ***Costal cartilages** – hyaline cartilage – attached to anterior ends of the ribs and continue in line w/ them toward the sternum.
- ***Anterior end** – sternal end
 - **True or vertebrosteral** – superior 7 prs. – join sternum directly by costal cartilage
 - **False or inferior** – 5 prs. – cartilage do not reach sternum directly
 - **8th, 9th, 10th** – **vertebrochondral** - . cartilages of the upper three false ribs join the cartilages of the 7th ribs (last of the true ribs)
 - **11th, 12th** – floating ribs – no attachments to the sternum

Sternum or breast bone (long flat bone located in the middle of thoracic cage)

***Sternal angle:** manubrium and body lie on different planes- union of the two projects slightly forward –at the level of the second costal cartilage

*Red marrow w/in spongy bone of sternum and iliac crest often removed to diagnose diseases – sternal puncture – suction some marrow through a hollow needle

*sternum develops in 3 parts:

- **Manubrium** –notches on side that articulate w/ costal cartilage – also articulate with clavicles (sternal end) at **clavicular notch**
 - Manubrium remains a separate bone until it fuses w/ body mid 20's
- **Body of the sternum** – notches on side that articulate w/ costal cartilage
- **Xiphoid process** – tip of the sternum

PECTORAL GIRDLE: 2 clavicles & 2 scapulae

Clavicle or collar bone (rod like bone w/ elongated S shape)

*located at the base of the neck

*run horizontally b/t sternum & shoulders

- **Sternal end** - medial end (sternal) articulates w/ manubrium
- **Acromial end** - lateral (acromial) end articulates w/ scapulae

Scapula or shoulder blade –broad somewhat triangular bones located on either side of the back

*flat bodies with concave anterior surfaces

- **Spine** – posterior surface – divides scapula into unequal portions – ends at head containing two processes:
- **Acromion process** – forms tip of shoulder
- **Coracoid process** – curves anteriorly and inferiorly to the clavicle – articulates w/ clavicle and provides attachments for muscles of the upper limbs and chest. Also provides attachment for upper limb and chest muscles.
- **Glenoid cavity** – articulates w/ head of humerus
- **Superior border** – superior edge
- **Infraspinous fossa** – below spine
- **Supraspinous fossa** – above spine
- **Lateral (axillary) border** – directed towards the upper limb (same side as glenoid cavity)
- **Medial (vertebral) border** - closest to the vertebral column – about 5 cm away

UPPER LIMBS

Humerus or upper arm bone – long bone that extends from scapula to elbow

- **Head** – upper end – smooth and rounded – fits into glenoid cavity of scapula
- **Anatomical neck** - narrow depression along the lower margin of the head – separates it from tubercle
- **Surgical neck** – below head & tubercles – named b/c fractures often occur here
- **Greater tubercle** – below head on lateral side – attachment of muscles that move upper limb at the shoulder
- **Lesser tubercle** – on anterior side of head – attachment of muscles that move upper limb at the shoulder
- **Intertubercular groove** – b/t lesser & greater tubercle – a tendon passes from a muscle in the arm (biceps brachii) to the shoulder
- **Deltoid tuberosity** (rough V shaped area on lateral side of bony shaft) – provides attachment for the muscle (deltoid) that raises the upper limb horizontally to the side
- **Olecranon fossa** – depression on posterior surface – receives olecranon process when upper limb straightens at the elbow – allows free movement of ulna
- **Coronoid fossa** – depression between epicondyles anteriorly – receives a process of the ulna (coronoid process) when the elbow bends – allows free movement of ulna
- **Lateral & medial epicondyles** – above condyles - provide attachments for muscles and ligaments of the elbow

Two smooth condyles at the lower end of the humerus:

- **Capitulum** – lateral side – articulates w/ radius at the elbow
- **Trochlea** – medial side – articulates w/ ulna

Radius (located on thumb side of forearm)

*shorter than ulna

*extends from elbow to wrist and crosses over ulna when the hand is turned so that the palm faces backward

- **Head of radius** – disk like faces towards midline – articulates w/ capitulum of the humerus and a notch of the ulna (radial notch) – allows radius to rotate freely
- **Radial tuberosity** – just below head – attachment for biceps brachii – bends upper limb at elbow-
- **Styloid process** – distal end – provides attachments for ligaments of the wrist

Ulna – longer than radius and overlaps the end of the humerus posteriorly – located on little pinky side

- **Trochlear notch (semilunar notch)** – proximal end wrenchlike opening – articulates w/ trochlea of humerus – olecranon and coronoid processes lie on either side
- **Olecranon process** - located above trochlear notch – provides attachment for triceps brachii that straightens the upper limb at the elbow. During this movement the olecranon process of the ulna fits into the olecranon fossa of the humerus.
- **Coronoid process** – just below the trochlear notch – fits into the coronoid fossa of the humerus when the elbow bends – elbow can only bend so far
- ***Head** – distal end of ulna – articulates laterally w/ radius at radial notch
- **Radial notch** – articulates with radius at ulnar notch & w/ a disk of fibrocartilage inferiorly
- **Styloid process** – media – at distal end of ulna- provides attachment for ligaments of the wrist

Carpal bones or wrist (8 bones)

*junction of the forearm and the hand

*8 small bones that are firmly found in 2 rows of 4 bones each

*resulting compact mass called a **carpus**

*carpus is rounded on proximal surface where it articulates w/ the radius & w/ a fibrocartilaginous disk on the ulnar side

*carpus is concave anteriorly forming a canal through which tendons and nerves extend to the palm

*distal surface articulates w/ metacarpal bones

Proximal row:

- **Pisiform** – pinky side
- **Triquetrum**
- **Lunate** – articulates w/ ulna
- **Scaphoid** – articulates w/ radius

Distal row:

- **Trapezium** – thumb side
- **Trapezoid**
- **Capitate**
- **Hamate** – pinky side

The hand is composed of a palm and 5 fingers – 5 metacarpal bones – palm & phalanges 14 finger bones (3 e/ finger & 2 thumb)

Metacarpals (5)– thumb is number 1

Phalanges – finger bones

- Proximal, middle distal phalanx
- 14 finger bones of the hand

BONES OF THE PELVIC GIRDLE

- * consists of 2 coxae, hipbones, which articulate w/ each other anteriorly and w/ sacrum posteriorly
- * sacrum, coccyx & pelvic girdle together form bowl-shaped pelvis
- * pelvic girdle supports trunk of the body, provides attachment for lower limbs, & protects the urinary bladder, the distal end of the large intestine and the internal reproductive organs
- * body weight is transmitted through the pelvic girdle to the lower limbs & then onto the ground

Coxal bone

- * each coxa develops from 3 parts – an ilium, an ischium and a pubis
- * 3 parts fuse at the **acetabulum** – depression on the lateral surface of the hipbone – this receives the head of the femur or thighbone

- **Ilium** – largest & most superior portion of coxa – flares outward forming the prominence of the hip
- ***Sacroiliac joint** – where ilium and sacrum join on the posterior side
- **Iliac crest** – margin on the ilium
- **Posterior superior iliac spine** – posterior border of ilium – below this spine is a deep indentation – greater sciatic notch through which a number of nerves (sciatic) & blood vessels pass
- **Anterior superior iliac spine** – projection of ilium – can be felt lateral to the groin – provides attachment for ligaments and muscles – important surgical landmark – common injury in contact sports is the bruising of soft tissues and bone of the anterior superior iliac spine – wearing protective padding important
- **Iliac fossa** – concave surface on the anterior aspect of the ilium
- **Acetabulum** – depression on the lateral surface of the hipbone – receives the head of the femur or thighbone
- **Ischium** – forms lowest portion of coxa - L-shaped w/ its angle, ischial tuberosity pointed posteriorly and downward
- **Ischial spine** – above ischial tuberosity near the junction of the ilium & ischium – sharp projection – can be felt during vaginal exams – helps determine size of pelvis – the distance b/t ischial spines is the shortest diameter of the pelvic outlet
- **Ischial tuberosity** – points posteriorly and downward on ischium – rough surface provides attachments for ligaments and lower limb muscles. Also supports weight of the body during sitting
- **Obturator foramen** – largest foramen of the body – obturator membrane covers & nearly closes this foramen
- **Pubis** – anterior portion of the coxa – 2 pubic bones come together at the midline and form a joint called the **symphysis pubis** – the angle that these bones form below the symphysis is **pubic arch** – a portion of e/ pubis passes anteriorly and downward to join an ischium – cartilage expands for head during childbirth

Major differences b/t male & female pelvis

- * b/c of functions of the female pelvis as a birth canal
- * female **iliac bones** are more flared than those of the male
- * female hips are usually broader than the male's
- * angle of the female **pubic arch** may be greater – may be more distance b/t the **ischial spines** and the **ischial tuberosities** and the sacral curvature may be shorter and flatter
- * female pelvic cavity is usually wider in all diameters than that of the male
- * bones of the female pelvis are usually lighter, more delicate, and show less evidence of muscle attachments

LOWER LIMBS OF THE BODY

*bones form the framework of the thigh, leg, and foot

*include femur, tibia fibula, tarsals, metatarsals, and phalanges

Femur (thigh bone)

*longest bone in the body – extends from the hip to the knee

- **Head** – large rounded head – proximal end extends medially into the acetabulum of the coxal bone
- **Neck** – constriction below the head
- **Fovea capitis** – pit on the head- marks the attachment of a ligament
- **Greater trochanter** – superior, lateral process that provided attachments for muscles of the lower limbs and buttocks
- **Lesser trochanter** – inferior, medial process that provided attachments for muscles of the lower limbs and buttocks
- **Linea aspera** – longitudinal crest on the posterior surface in the middle third of the shaft. Rough surface is attachment for muscles
- **Lateral epicondyle** – lateral surface of distal end – superior to lateral condyle - attachment of muscles and ligaments
- **Medial epicondyle** – medial surface of distal end – superior to medial condyle - attachment of muscles and ligaments
- **Intercondylar fossa** – pit or depression b/t medial and lateral condyles
- **Patellar surface** – articulates w/ femur on its distal anterior surface
- **Lateral and medial condyle** - distal end of femur articulates with tibia – covered w/ articular cartilage

Patella (knee cap)

*flat sesmoid bone located in a tendon that passes anteriorly over the knee

*b/c of its position, it controls angle at which this tendon continues toward the tibia – functions in lever actions associated w/ lower limb movement

*blow to the knee, patella sometimes slips to one side – patellar dislocation – decrease chances of occurring by exercising – strengthen muscles that control knee – and wearing protective gear. Once soft tissues that hold patella in place are stretched, patellar dislocation tends o recur

Tibia (shinbone)

*larger of the two bones of the lower leg

*located on the medial side

- **Medial condyle** – proximal end of tibia, concave surface that articulates w/ the condyles of the femur
- **Lateral condyle** - - proximal end of tibia, concave surface that articulates w/ the condyles of the femur
- **Tibial tuberosity** – below condyles on anterior surface – provides attachment for patellar ligament (continuation of the patella-bearing tendon)
- **Anterior crest** – extends downward from tibial tuberosity – muscle attachment
- **Medial Malleolus** – distal end – forms inner ankle – attachment for ligaments
- * on lateral distal end - depression that articulates w/ fibula
- *the inferior surface of the tibia's distal end articulates w/ a large bone (the talus) in the foot

Fibula

*long, slender bone located on the lateral side of the tibia

- **Head of the fibula** – slightly enlarged proximal end – articulates w/ the tibia just below the lateral condyle – however it does not enter into the knee joint and does not bear any body weight
- **Lateral malleolus** - slightly enlarged distal end – articulates with the ankle and protrudes on the lateral side – outer ankle

FOOT

7 tarsal (ankle bones)

*ankle and foot consists of a tarsus, a metatarsus, and 5 toes

*tarsus consists of 7 tarsal bones – arranged so that talus can move freely where joins tibia & fibula - remaining talus bones are bound firmly together forming a mass supporting the talus

- **Medial cuneiform**
- **Intermediate cuneiform**
- **Lateral cuneiform**
- **Cuboid**
- **Navicular**
- **Talus** – can move freely where it joins the tibia and fibula – thus forming the ankle
- **Calcaneus (heel bone)** – largest of the tarsals located below the talus where it projects backward to form the base of the heel – helps support the weight of the body and provides attachment for muscles that move the foot

5 Metatarsal bones (instep)

*forms metatarsus

*articulate w/ tarsus

*numbered 1-5 beginning on the medial side

*heads at distal ends of these bones form the ball of the foot

*tarsals & metatarsals are arranged and bound by ligaments to form the arches of the foot

*longitudinal arch extends from the heel to the toe

*transverse arch stretches across the foot

*these arches provide a stable, springy base for the body

*sometimes these tissues that bind the metatarsals weaken, producing fallen arches, or flat feet

Phalanges (toes)

*shorter but otherwise similar to fingers

*align and articulate w/ metatarsals

*e/ toe has 3 phalanges (except great toe - lacks middle phalanx):

- **Proximal phalanx**
- **Middle phalanx**
- **Distal phalanx**

Hyoid bone

*located in the neck b/t the lower jaw and the larynx

*it is the only bone that does not articulate w/ another bone

*fixed into position by muscles and ligaments

*supports the tongue and is an attachment for certain muscles that help move the tongue during swallowing

*can be felt approximately a finger's width above the anterior prominence of the larynx

Middle ear bones

*auditory ossicles – attached to the wall of the tympanic cavity by tiny ligaments and are covered by mucous membranes

*bridge the tympanic membranes and the inner ear, transmitting vibrations between these parts

- **Malleus (hammer)** – attached to the tympanic membrane – when membrane vibrates, malleus vibrates in unison w/ it – malleus vibrates the incus
- **Incus (anvil)** – incus vibrates the stapes
- **Stapes (stirrup)** – ligaments hold the stapes to an opening in the wall of the tympanic cavity called the oval window. Vibration of stapes acts like a piston at the oval window – moves fluid within the inner ear
- *these vibrations of the fluid stimulate the hearing receptors
- *ossicles also form a lever system that helps increase (amplify) the force of the vibrations as they pass from the tympanic membrane to the oval window
- *vibrational force also concentrates as it travels from the external to the inner ear b/c ossicles transmit vibrations from the large surface of the tympanic membrane to a much smaller area at the oval window