بسم الله الرحمن الرحيم ورحمة الله وبركاته H u m a n Anatomy L e c t u r e 1 Bones o f skull &Cranial f o r a m i n a B y Assistant professor Dr. Hatem A Hatem Collage of Medicine–In sina university Department of Anatomy 2 0 2 3 – 2 0 2 4 Objectives of this lecture to know about the bones of the skull: ● Cranium ● Face ● Sutures of the Skull ● Clinical Relevance. Skull : ● Bony structure that supports face and forms a protective cavity for brain. ● Comprised of many bones, joined by sutures. ● Bones of skull divided into those of cranium (subdivided to skullcap(calvarium), and cranial base) and those of face. Cranium (neurocranium) ● Formed by superior aspect of skull. It encloses and protects brain, meninges and cerebral vasculature. ● Subdivided into a roof (calvarium), and a base: 1. Calvarium: Comprised of frontal, occipital and two parietal bones. 2. Cranial base: Comprised of six bones –frontal, sphenoid, ethmoid, occipital, parietal and temporal bones. Face ● Facial skeleton (viscerocranium) supports soft tissues of face. ● they determine our facial appearance. ● Consists of 14 individual bones. ● Frontal bone, typically a bone of calvaria, is sometimes included as part of facial skeleton. Facial skeleton ●Zygomatic (2) . ●Lacrimal (2) . ●Nasal (2) . ●Inferior nasal conchae (2) . ●Palatine (2) . ●Maxilla (2) . ●Vomer . ●Mandible (jawbone) . Cranial bones(8) Facial bones(14) Zygomatic (2) – Forms cheekbones of face, and articulates with frontal, sphenoid, temporal and maxilla bones. Lacrimal (2) – smallest bones of face. Form part of medial wall of orbit. Nasal (2) – Two slender bones, located at the bridge of the nose. Inferior nasal conchae (2) – Located within nasal cavity to increase surface area of nasal cavity, thus increasing amount of inspired air. Palatine (2) – Situated superior to oral cavity, and forms part of hard palate. Maxilla (2) – Comprises part of the upper jaw and hard palate. Maxillae: 2maxillae form upper jaw. Below orbit, maxilla is perforated by infraorbital foramen. Alveolar process projects downward &, with opposite side, alveolar arch, carries upper teeth. Vomer – Forms the posterior aspect of the nasal septum. Mandible (jawbone) – Articulates with base of cranium at temporomandibular joint (TMJ). Mandible (lower jaw) Largest and strongest bone of face. ● Body in midline, has a ridge line of fusion at symphysis menti. Body meets ramus at the angle of mandible Mandible Body : upper border called alveolar part; contains 16 sockets for roots of teeth. Lower border called base. Mandible Ramus: vertically placed has: ant.coronoid process. post.condyloid process. 2 processes separated by mandibular notch. Temporal Bone Parts : A. Squamous. B. Tympanic. C. Mastoid process. D. Styloid process. E. Zygomatic process. Sutures of the Skull ● Type of fibrous joint unique to skull. ● Immovable. ● Fuse completely around age of 20. ● Sutures are of clinical importance, as they can be points of potential weakness in both childhood and adulthood. ● Main sutures in adulthood are: ● ●Coronal suture. ● ●Sagittal suture. ● ●Lambdoid suture. In neonates, incompletely fused suture joints give rise to membranous gaps between bones, known as fontanelles. Two major fontanelles are frontal fontanelle (located at junction of coronal and sagittal sutures) and occipital fontanelle (located at junction of sagittal and lambdoid sutures). ● The majority of skull fractures result from blunt force or penetrating trauma. ● The clinical features may be obvious, such as visible injuries and bleeding. There are also subtle signs of fracture, such as clear fluid draining from ears and nose, poor balance and confusion, slurred speech and a stiff neck. Pterion: ● A ‘H–shaped’ junction between temporal, parietal, frontal and sphenoid bones. ● The thinnest part of skull. ● A fracture here can lacerate an underlying artery (middle meningeal artery), resulting in a extradural hematoma. There are four major types of cranial fracture:

Depressed– fracture of bone with depression of bone inwards. They occur as a result of a direct blow, causing skull indentation, with possible underlying brain injury. Linear – a simple break in bone, traversing its full thickness. They have radiating (stellate) fracture lines away from the point of impact. The most common type of cranial fracture. Basal skull– affects the base of skull. They characteristically present with bruising behind the ears, known as Battle's sign (mastoid ecchymosis) or bruising around the eyes/orbits, known as Raccoon eyes. Diastatic– fracture that occurs along a suture line, causing a widening of suture. Most often seen in children. ● Facial fractures are common and generally trauma related, i.e. road traffic collisions, fights and falls. ● They are often associated with clinical features such as profuse bleeding, swelling, deformity and anaesthesia of the skin. ● The nasal bones are most frequently fractured, due to their prominent position at the bridge of the nose. ● A maxillofacial fracture is one that affects the maxillae bones. This requires a trauma with a large amount of force. Facial fractures affecting the maxillary bones can be identified using the Le Fort classification, depending on the bones involved, ranging from 1 to 3 (most serious). Bones of Head: 1. Ethmoid bone . 2. Mandible. 3. Sphenoid bone . 4. Temporal bone. 5. Nasal skeleton. Cranial foramina: 1. Cribriform Foramina. 2. Optic Canal and Foramen. 3. Superior Orbital Fissure. 4. Foramen Rotundum. 5. Foramen Ovale. 6. Internal Acoustic Meatus. 7. Jugular Foramen. 8. Hypoglossal Canal. 9. Foramen Magnum. 10.Foramen Spinosum. Ethmoid bone: 1. A small–unpaired bone, located in midline of anterior cranium . 2. Term 'ethmoid' originates from Greek 'ethmos', meaning sieve. This is reflects in its lightweight, spongy structure. Anatomical Structure ● Situate at roof of nasal cavity, and between two orbital cavities. ● Contributes to medial wall of orbit and forms part of anterior cranial fossa, where it separates nasal cavity (inferiorly) from cranial cavity (superiorly). ● Forms a significant portion of nasal septum and lateral nasal wall. ● Olfactory nerve (CN I) has a close anatomical relationship with ethmoid bone. Its numerous nerve fibers pass through cribriform plate of ethmoid bone to innervate nasal cavity with sense of smell. Ethmoid bone made up of three parts : 1. Cribriform plate. 2. Perpendicular plate. 3. Ethmoidal labyrinth. ● Cribriform plate forms roof of nasal cavity. Numerous olfactory nerve fibers pierce it, which gives it a sieve–like structure. ● Projecting superiorly from cribriform plate is crista galli, which provides an attachment point for falx cerebri (sheet of dura mater that separates two cerebral hemispheres). ● Another projection of bone descends from cribriform plate ,perpendicular plate. It forms superior two–thirds of nasal septum. Ethmoid bone made up of three parts : ● Lastly, Ethmoid bone contains two ethmoidal labyrinths. These are large masses located at either side of perpendicular plate, contain ethmoidal air sinuses. Two sheets of bone form each labyrinth: 1.Orbital plate – lateral sheet of bone, which also forms medial wall of orbit 2.Medial sheet – forms upper lateral wall of nasal cavity, from which superior and middle conchae extend into nasal cavity. Articulations Ethmoid bone articulates with 13 others: ● Paired– nasal bones, maxillae, lacrimal bones, palatine bones, inferior conchae. ● Unpaired– frontal, vomer and sphenoid bones. Mandible: ● Located inferiorly in facial skeleton. ● Largest and strongest bone of face. ● Forms lower jaw and acts as a receptacle for lower teeth. ● Articulates on either side with temporal bone, forming temporomandibular joint. Anatomical Structure Mandible consists of a horizontal body (anteriorly) and two vertical rami (posteriorly). Body and rami meet on each side at angle of mandible. Body of mandible: 1. Curved, and shaped much like a horseshoe ,has two borders:

●Alveolar border (superior) – contains 16 sockets to hold lower teeth. ●Base (inferior) – site of attachment for digastric muscle medially. 2. Marked in midline by mandibular symphysis. The symphysis encloses a triangular eminence –mental protuberance, which forms shape of chin. 3. Lateral to mental protuberance is mental foramen (below second premolar tooth on either side). Rami 1. Two rami project perpendicularly upwards from angle of mandible. 2. Each ramus contains following bony landmarks: ●Head – situated posteriorly, articulates with temporal bone to form TM joint. ●Neck – supports head of ramus, and site of attachment of lateral pterygoid muscle. ●Coronoid process – site of attachment of temporalis muscle 3.Internal surface of ramus also marked by mandibular foramen. Foramina of mandible: Any opening through which neurovascular structures can travel. Mandible is marked by two foramina. 1. Mandibular foramen located on internal surface of ramus of mandible. It serves as a conduit for inferior alveolar nerve and inferior alveolar artery. They travel through mandibular foramen, into mandibular canal, and exit at mental foramen. 2. Mental foramen, positioned on external surface of mandibular body, below second premolar tooth. It allows inferior alveolar nerve and artery to exit mandibular canal. When inferior alveolar nerve passes through mental foramen, it becomes mental nerve (innervates skin of lower lip and front of chin). Muscular Attachments Mandible serves as attachment point for various muscles, including strong muscles of mastication. ●Mandibular body: O External (lateral) surface – mentalis, buccinator, platysma, depressor labii inferioris, depressor anguli oris. O Internal (medial) surface – genioglossus, geniohyoid, mylohyoid and digastric. Muscular Attachments ●Mandibular rami– masseter, temporalis, medial pterygoid and lateral pterygoid. Temporalis muscle attaches to coronoid process, and masseter attaches to rami. Lateral pterygoid inserts into neck of mandible, and medial pterygoid inserts into ramus near angle of mandible. Sphenoid bone ● Name derived from Greek ‘sphenoeides’, to mean wedge– shaped. Anatomical Structure ● Butterfly–shaped consists of a body, paired greater wings and lesser wings, and two pterygoid processes. Body ● Lies at center of sphenoid bone, cubical in shape. ● Contains sphenoidal sinuses, which separated by a septum. ● Articulates with ethmoid bone anteriorly. Sphenoid bone Superior surface of sphenoid body contains : ● Sella turcica– a saddle–shaped depression. It has three parts: o Tuberculum sellae– forms anterior wall of sella turcica, and posterior aspect of chiasmatic groove. o Hypophyseal fossa –deepest part of sella turcica, where pituitary gland is located. o Dorsum sellae– forms posterior wall of sella turcica. Chiasmatic groove : ● A sulcus formed by optic chiasm (where optic nerves partially cross). ● Anterior and posterior clinoid processes surround sella turcica. ● Anterior clinoid processes arise from sphenoidal lesser wings, while posterior clinoid processes are superolateral projections of dorsum sellae. ● They serve as attachment points for tentorium cerebelli, a membranous sheet that divides brain. Greater Wing Extends from sphenoid body in a lateral, superior and posterior direction. Contributes to three parts of facial skeleton: ●Floor of middle cranial fossa ●Lateral wall of skull ●Posterolateral wall of orbit Three foramina present in greater wing: foramen rotundum, foramen ovale and foramen spinosum. They conduct maxillary nerve, mandibular nerve and middle meningeal vessels respectively. Lesser Wing ● Arises from anterior aspect of sphenoid body in a superolateral direction. ● Separates anterior cranial fossa from middle cranial fossa. ● It also forms lateral border of optic canal – through which optic nerve and ophthalmic artery travel to reach eye. ● Body of sphenoid

forms medial border of optic canal. ● There is a 'slit-like' gap between lesser and greater wings of sphenoid (superior orbital fissure). Pterygoid Process ● Descends inferiorly from point of junction between sphenoid body and greater wing. ● It consists of two parts: 1. Medial pterygoid plate – supports posterior opening of nasal cavity. 2. Lateral pterygoid plate – site of origin of medial and lateral pterygoid muscles Muscular Attachments ● Lateral and medial pterygoid muscles, which form some of muscles of mastication, originate from lateral pterygoid plate of sphenoid bone. Articulations It has articulations with twelve other bones: ●Unpaired bones – Occipital, vomer, ethmoid and frontal bones. ●Paired bones – Temporal, parietal, zygomatic and palatine bones. Temporal bone ● Contributes to lower lateral walls of skull. ● Contain middle and inner portions of ear, and crossed by majority of cranial nerves. ● Lower portion of bone articulates with mandible, forming TMJ. Anatomical Structure ● Comprised of five constituent parts. ● Squamous, Tympanic and petromastoid parts make up majority of bone, with zygomatic and styloid processes projecting outwards. Parts of temporal bone in more detail. Squamous ● Also known as squama temporalis, largest part of temporal bone. ● It is flat and plate-like, located superiorly. ● Outer facing surface of squamous bone is convex in shape, forming part of temporal fossa. ● Lower part of squamous bone is site of origin of temporalis muscle ● Bone articulates with sphenoid bone anteriorly, and parietal bone laterally. Zygomatic Process ● Arises from lower part of squama temporalis. ● Projects anteriorly, articulating with temporal process of zygomatic bone , form zygomatic arch (palpable as 'cheek bones'). ● Zygomatic processes forms articular tubercle –anterior boundary of mandibular fossa, part of TMJ. ● Masseter muscles attaches to lateral surface of zygomatic process. Tympanic ● Lies inferiorly to squamous, and anteriorly to petromastoid part. ● Surrounds external auditory opening, leads into external auditory meatus of external ear. Styloid Process Located immediately underneath opening to auditory meatus. Acts as an attachment point for muscles and ligaments, such as Stylomandibular ligament of TMJ. Petromastoid ● Located posteriorly. ● Split into mastoid and petrous parts. ● On a lateral view of temporal bone, only mastoid part is visible. Mastoid process: ● An inferior projection of bone, palpable just behind ear. ● It is a site of attachment for many muscles, such as sternocleidomastoid. ● Also of clinical importance are mastoid air cells. Mastoid process: 1. These hollowed out areas within temporal bone. 2. They act as a reservoir of air, equalizing pressure within middle ear in case of auditory tube dysfunction. 3. Mastoid air cells might be infected, known as mastoiditis. Petrous part is pyramidal shaped, and lies at base of temporal bone. It contains inner ear. Muscular Attachments of temporal bone Muscle Site of Attachment Description Temporalis Originates from the Muscle of mastication lower part of squamous Masseter Lateral zygomatic Muscle of mastication surface Sternocleidomastoid Mastoid process Superficial muscle of the neck. Involved in rotation of head and flexion of neck. Important landmark for the anterior and posterior cervical triangles. Posterior belly of digastric Mastoid process A suprahyoid muscle. Involved in processes such as swallowing. Articulations of temporal bone: ● A major articulation of temporal bone is with mandible to form TMJ. ● Squamous part articulates with sphenoid bone anteriorly and parietal bone laterally. ● Zygomatic process articulates with zygomatic bone to form zygomatic arch (i.e. cheekbones). Nasal skeleton : Combination of bone and cartilage, both form external nose and internal nasal septum. Anatomical Structure ● Skeleton of nose is formed by three types of tissue; bone, cartilage and fibro-

fatty tissue. ● Scaffolding of nose is divide into two parts; external nasal skeleton and internal nasal septum. External Nasal skeleton ● Extends nasal cavities onto front of face. ● Partly formed by nasal and maxillary bones, situated superiorly. ● Inferior portion of nose made up of hyaline cartilages; lateral, major alar, minor alar, and cartilaginous septum. ● Lateral and major alar cartilages are largest, and contribute most to shape of nose here. ● Minor alar cartilages vary in number; there are usually 3 or 4 on each side. Internal Nasal Septum ● Separates nasal cavity into two nostrils. ● Bones contribute to nasal septum divided into: 1. Paired bones: Nasal, maxillary and palatine bones 2. Unpaired bones: Ethmoid and vomer bones. Internal Nasal Septum In addition to bones of nose, septal and greater alar cartilages also constitute part of nasal septum. ● Ethmoid contributes to central portion of nasal septum. It is one of the most complex bones in the human body. ● Anterior and posterior parts formed by the septal cartilage and vomer bone respectively. ● Floor of nasal cavity formed by hard palate, separating it from oral cavity. ● Hard palate consists of palatine bone posteriorly, and palatine process of maxilla anteriorly. ● Cribriform plate of ethmoid bone forms posterior roof. A foramen (pl. foramina): ● An opening that allows passage of structures from one region to another. ● In skull base, referred to as cranial foramina. Cranial Nerve Foramina: Cribriform Foramina ● Numerous perforations in cribriform plate of ethmoid bone. Connect anterior cranial fossa with nasal cavity. ● Allow passage of axons of olfactory nerve from olfactory epithelium of nose into anterior cranial fossa where they communicate with olfactory bulb. Optic Canal and Foramen ● Optic canal permits passage of optic nerve (CN II) and ophthalmic artery into bony orbit. ● Bounded medially by body of sphenoid, laterally by lesser wing . Superior Orbital Fissure ● A cleft that opens anteriorly into orbit. ● Bordered superiorly by lesser wing and inferiorly by greater wing . ● Transmits several structures that listed below (from superior to inferior): 1. Lacrimal nerve. 2. Frontal nerve – branch of ophthalmic nerve of trigeminal nerve (CN V). 3. Superior ophthalmic vein. 4. Trochlear nerve (CN IV).. 5. Superior division of Oculomotor nerve (CN III). 6. Nasociliary nerve – branch of ophthalmic nerve of trigeminal nerve (CN V). 7. Inferior division of Oculomotor nerve (CN III). 8. Abducens nerve (CN VI). 9. A branch of Inferior ophthalmic vein. Foramen Rotundum ● Located at base of greater wing, inferior to superior orbital fissure. ● Provides a connection between middle cranial fossa and pterygopalatine fossa. ● Maxillary nerve (branch of trigeminal nerve, CN V) passes through this foramen. Foramen Ovale ● Located at base of greater wing of sphenoid. ● Posterolaterally to foramen rotundum within middle cranial fossa. ● Conducts mandibular nerve (branch of trigeminal nerve, CN V) and accessory meningeal artery. Foramen Spinosum ● Located within middle cranial fossa, laterally to foramen ovale. ● Allows passage of middle meningeal artery, middle meningeal vein and meningeal branch of CN V3. Internal Acoustic Meatus ● Bony passage located within petrous part of temporal bone. ● Connects posterior cranial fossa and inner ear. ● Transporting neurovascular structures to the auditory and vestibular apparatus. ● Facial and vestibulocochlear nerves pass through internal acoustic meatus, alongside vestibular ganglion and labyrinthine artery. Jugular Foramen ● Formed anteriorly by petrous part of temporal bone and posteriorly by occipital bone. ● Considered as three separate compartments with their respective contents: 1. Anterior – contains inferior petrosal sinus (a Dural venous sinus). 2. Middle – transmits glossopharyngeal nerve, vagus nerve and cranial part of accessory nerve. 3. Posterior – contains sigmoid sinus, and transmits meningeal branches of occipital and

ascending pharyngeal arteries. Hypoglossal Canal Located in occipital bone, hypoglossal nerve (CN XII) passes to exit posterior cranial fossa. Foramen Magnum ● Largest of cranial foramina. ● Lies in occipital bone within posterior cranial fossa, and allows passage of medulla and meninges, vertebral arteries, anterior and posterior spinal arteries and dural veins. ● Spinal division of accessory nerve ascends through foramen magnum to join cranial division. Once combined, completed nerve exits through jugular foramen .