Lecture 7 The Eye د.أحمد جسام النقيب

The Eye

Movements of the Eyeball

Terms Used in Describing Eye Movements

The center of the cornea or the center of the pupil is used as the anatomic "anterior pole" of the eye. All movements of the eye are then related to the direction of the movement of the anterior pole as it rotates on any one of the three axes (horizontal, vertical, and sagittal). The terminology then becomes as follows: **Elevation** is the rotation of the eye upward, **depression** is the rotation of the eye downward, **abduction** is the rotation of the eye laterally, and **adduction** is the rotation of the eye medially. Rotatory movements of the eyeball use the upper rim of the cornea (or pupil) as the marker. The eye rotates either medially or laterally.

Extrinsic Muscles Producing Movement of the Eye

There are six voluntary muscles that run from the posterior wall of the orbital cavity to the eyeball. These are the **superior rectus,** the **inferior rectus,** the **medial rectus,** the **lateral rectus,** and the **superior** and **inferior oblique muscles.** Because the superior and the inferior recti are inserted on the medial side of the vertical axis of the eyeball, they not only raise and depress the cornea, respectively, but also **rotate it medially**.

For the superior rectus muscle to raise the cornea directly upward, the inferior oblique muscle must assist; for the inferior rectus to depress the cornea directly downward, the superior oblique muscle must assist. Note that the tendon of the superior oblique muscle passes through a fibrocartilaginous pulley (trochlea) attached to the frontal bone. The tendon now turns backward and laterally and is inserted into the sclera beneath the superior rectus muscle.

TABLE 11.2 Muscles of the Eyeball and Eyelids

Muscle	Origin	Insertion	Nerve Supply	Action
Extrinsic Muscles of Eyeball (Striated Skeletal Muscle)				
Superior rectus	Tendinous ring on posterior wall of orbital cavity	Superior surface of eyeball just posterior to corneoscleral junction	Oculomotor nerve (3rd cranial nerve)	Raises cornea upward and medially
Inferior rectus	Tendinous ring on posterior wall of orbital cavity	Inferior surface of eyeball just posterior to corneoscleral junction	Oculomotor nerve (3rd cranial nerve)	Depresses cornea downward and medially
Medial rectus	Tendinous ring on posterior wall of orbital cavity	Medial surface of eyeball just posterior to corneoscleral junction	Oculomotor nerve (3rd cranial nerve)	Rotates eyeball so that cornea looks medially
Lateral rectus	Tendinous ring on posterior wall of orbital cavity	Lateral surface of eyeball just posterior to corneoscleral junction	Abducent nerve (6th cranial nerve)	Rotates eyeball so that cornea looks laterally
Superior oblique	Posterior wall of orbital cavity	Passes through pulley and is attached to superior surface of eyeball beneath superior rectus	Trochlear nerve (4th cranial nerve)	Rotates eyeball so that cornea looks downward and laterally
Inferior oblique	Floor of orbital cavity	Lateral surface of eyeball deep to lateral rectus	Oculomotor nerve (3rd cranial nerve)	Rotates eyeball so that cornea looks upward and laterally
Intrinsic Muscles of Eyeball (Smooth Muscle)				
Sphincter pupillae of iris			Parasympathetic via oculomotor nerve	Constricts pupil
Dilator pupillae of iris			Sympathetic	Dilates pupil
Ciliary muscle			Parasympathetic via oculomotor nerve	Controls shape of lens; in accommodation, makes lens more globular

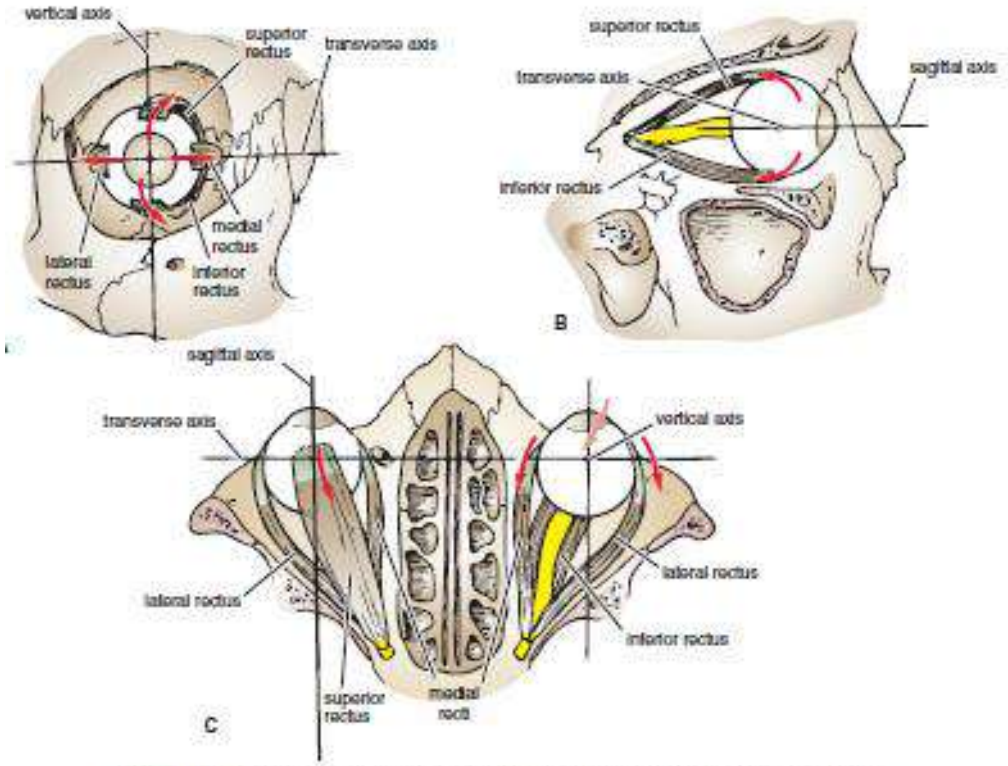


FIGURE 11.21 The actions of the four recti muscles in producing movements of the eyeball.

Clinical Testing for the Actions of the Superior and Inferior Recti and the Superior and Inferior Oblique Muscles

Because the actions of the superior and inferior recti and the superior and inferior oblique muscles are complicated when a patient is asked to look vertically upward or vertically downward, the physician tests the eye movements where the single action of each muscle predominates. The origins of the superior and inferior recti are situated about 23° medial to their insertions, and, therefore, when the patient is asked to turn the cornea laterally, these muscles are placed in the optimum position to raise (superior rectus) or lower (inferior rectus) the cornea. Using the same rationale, the superior and inferior oblique muscles can be tested. The pulley of the superior oblique and the origin of the inferior oblique muscles lie medial and anterior to their insertions. The physician tests the action of these muscles by asking the patient first to look medially, thus placing these muscles in the optimum position to lower (superior oblique) or raise (inferior oblique) the cornea. In other words, when you ask a patient to look medially and downward at the tip of his or her nose, you are testing the superior oblique at its best position. Conversely, by asking the patient to look medially and upward, you are testing the inferior oblique at its best position

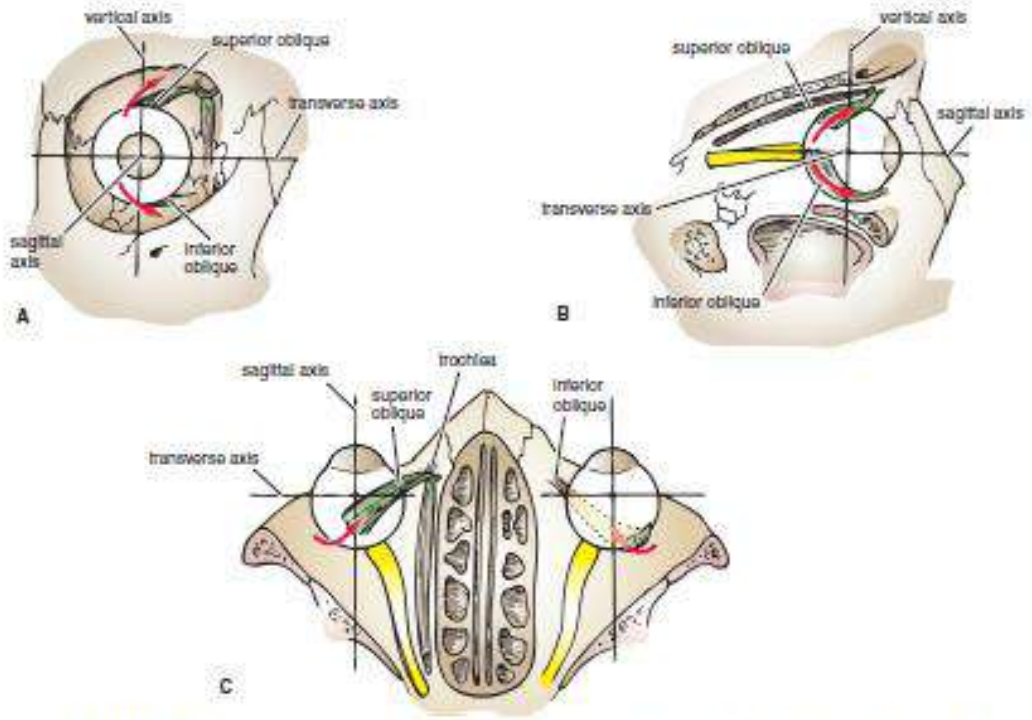


FIGURE 11.22 The actions of the superior and inferior oblique muscles in producing movements of the eyeball.

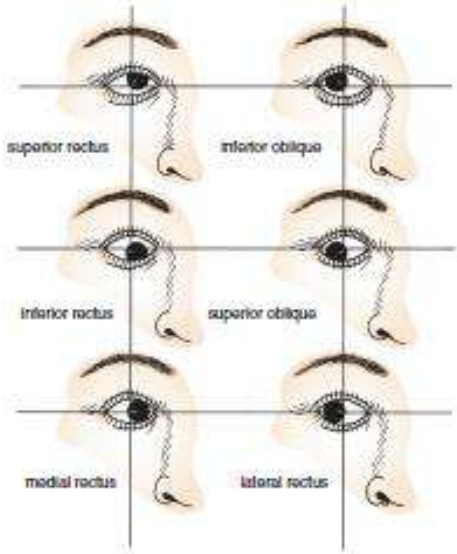


FIGURE 11.23 Actions of the four recti and two oblique muscles of the right orbit, assuming that each muscle is acting alone. The position of the pupil in relation to the vertical and horizontal planes should be noted in each case. The actions of the superior and inferior recti and the oblique muscles in the living intact eye are tested clinically, as described on page 557.

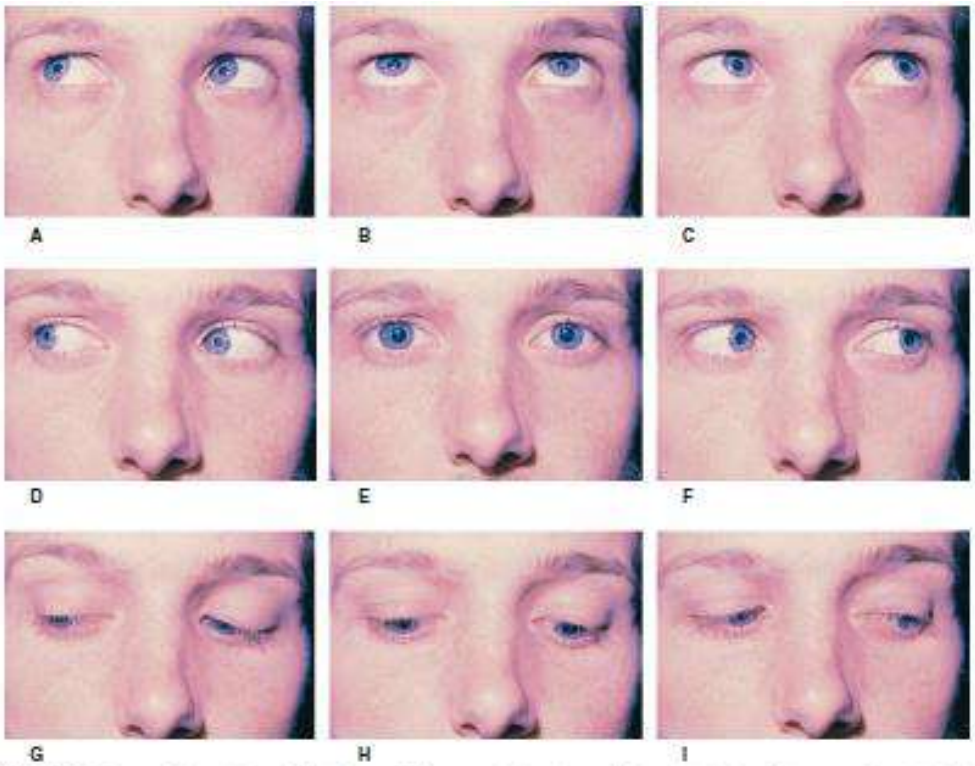


FIGURE 11.24 The cardinal positions of the right and left eyes and the actions of the recti and the oblique muscles principally responsible for the movements of the eyes. **A.** Right eye, superior rectus muscle; left eye, inferior oblique muscle. **B.** Both eyes, superior recti and inferior oblique muscles. **C.** Right eye, inferior oblique muscle; left eye, superior rectus muscle. **D.** Right eye, lateral rectus muscle; left eye, medial rectus muscle. **E.** Primary position, with the eyes fixed on a distant fixation point. **F.** Right eye, medial rectus muscle; left eye, lateral rectus muscle. **G.** Right eye, inferior rectus muscle; left eye, superior oblique muscle. **H.** Both eyes, inferior recti and superior oblique muscles. **I.** Right eye, superior oblique muscle; left eye, inferior rectus muscle.

Intrinsic Muscles

The involuntary intrinsic muscles are the **ciliary muscle** and the **constrictor,** and the **dilator pupillae of the iris** take no part in the movement of the eyeball and are discussed later.

Fascial Sheath of the Eyeball

The fascial sheath surrounds the eyeball from the optic nerve to the corneoscleral junction. It separates the eyeball from the orbital fat and provides it with a socket for free movement. It is perforated by the tendons of the orbital muscles and is reflected onto each of them as a tubular sheath. The sheaths for the tendons of the medial and lateral recti are attached to the medial and lateral walls of the orbit by triangular ligaments called the **medial** and **lateral check ligaments.** The lower part of the fascial sheath, which passes beneath the eyeball and connects the check ligaments, is thickened and serves to suspend the eyeball; it is called the **suspensory ligament of the eye.** By this means, the eye is suspended from the medial and lateral walls of the orbit, as if in a hammock.

Structure of the Eye

The eyeball is embedded in orbital fat but is separated from it by the fascial sheath of the eyeball. The eyeball consists of three coats, which, from without inward, are the fibrous coat, the vascular pigmented coat, and the nervous coat.

Coats of the Eyeball

Fibrous Coat

The fibrous coat is made up of a posterior opaque part, the sclera, and an anterior transparent part, the cornea. The Sclera The opaque sclera is composed of dense fibrous tissue and is white. Posteriorly, it is pierced by the optic nerve and is fused with the dural sheath of that nerve. The **lamina cribrosa** is the area of the sclera that is pierced by the nerve fibers of the optic nerve. The sclera is also pierced by the ciliary arteries and nerves and their associated veins, the venae vorticosae. The sclera is directly continuous in front with the cornea at the corneoscleral junction, or limbus.

The Cornea

The transparent **cornea** is largely responsible for the refraction of the light entering the eye. It is in contact posteriorly with the aqueous humor.

Blood Supply The cornea is avascular and devoid of lymphatic drainage. It is nourished by diffusion from the aqueous humor and from the capillaries at its edge.

Nerve Supply Long ciliary nerves from the ophthalmic division of the trigeminal nerve

Function of the Cornea

The cornea is the most important refractive medium of the eye. This refractive power occurs on the anterior surface of the cornea, where the refractive index of the cornea (1.38) differs greatly from that of the air. The importance of the tear film in maintaining the normal environment for the corneal epithelial cells should be stressed.

Vascular Pigmented Coat

The vascular pigmented coat consists, from behind forward, of the choroid, the ciliary body, and the iris.

The Choroid

The choroid is composed of an outer pigmented layer and an inner, highly vascular layer.

The Ciliary Body

The **ciliary body** is continuous posteriorly with the choroid, and anteriorly it lies behind the peripheral margin of the iris. It is composed of the ciliary ring, the ciliary processes, and the ciliary muscle.

The **ciliary ring** is the posterior part of the body, and its surface has shallow grooves, the **ciliary striae.**

The **ciliary processes** are radially arranged folds, or ridges, to the posterior surfaces of which are connected the suspensory ligaments of the lens.

The **ciliary muscle** is composed of meridianal and circular fibers of smooth muscle. The meridianal fibers run backward from the region of the corneoscleral junction to the ciliary processes. The circular fibers are fewer in number and lie internal to the meridianal fibers.

■ **Nerve supply:** The **ciliary muscle** is supplied by the parasympathetic fibers from the oculomotor nerve. After synapsing in the ciliary ganglion, the postganglionic fibers pass forward to the eyeball in the short ciliary nerves.

■ **Action:** Contraction of the ciliary muscle, especially the meridianal fibers, pulls the ciliary body forward. This relieves the tension in the suspensory ligament, and the elastic lens becomes more convex. This increases the refractive power of the lens.

The Iris and Pupil

The iris is a thin, contractile, pigmented diaphragm with a central aperture, the pupil. It is suspended in the aqueous humor between the cornea and the lens. The periphery of the iris is attached to the anterior surface of the ciliary body. It divides the space between the lens and the cornea into an **anterior** and a **posterior chamber.** The muscle fibers of the iris are involuntary and consist of circular and radiating fibers. The circular fibers form the **sphincter pupillae** and are arranged around the margin of the pupil. The radial fibers form the **dilator pupillae** and consist of a thin sheet of radial fibers that lie close to the posterior surface.

■ **Nerve supply:** The **sphincter pupillae** is supplied by parasympathetic fibers from the oculomotor nerve. After synapsing in the ciliary ganglion, the postganglionic fibers pass forward to the eyeball in the short ciliary nerves. The **dilator pupillae** is supplied by sympathetic fibers, which pass forward to the eyeball in the long ciliary nerves.

■ **Action:** The sphincter pupillae constricts the pupil in the presence of bright light and during accommodation.

The dilator pupillae dilates the pupil in the presence of light of low intensity or in the presence of excessive sympathetic activity such as occurs in fright.

Nervous Coat: The Retina

The retina consists of an **outer pigmented layer** and an **inner nervous layer.** Its outer surface is in contact with the choroid, and its inner surface is in contact with the vitreous body. The posterior three quarters of the retina is the receptor organ. Its anterior edge forms a wavy ring, the **ora serrata,** and the nervous tissues end here. The anterior part of the retina is nonreceptive and consists merely of pigment cells, with a deeper layer of columnar epithelium. This anterior part of the retina covers the ciliary processes and the back of the iris. At the center of the posterior part of the retina is an oval, yellowish area, the **macula lutea,** which is the area of the retina for the most distinct vision. It has a central depression, the **fovea centralis**.

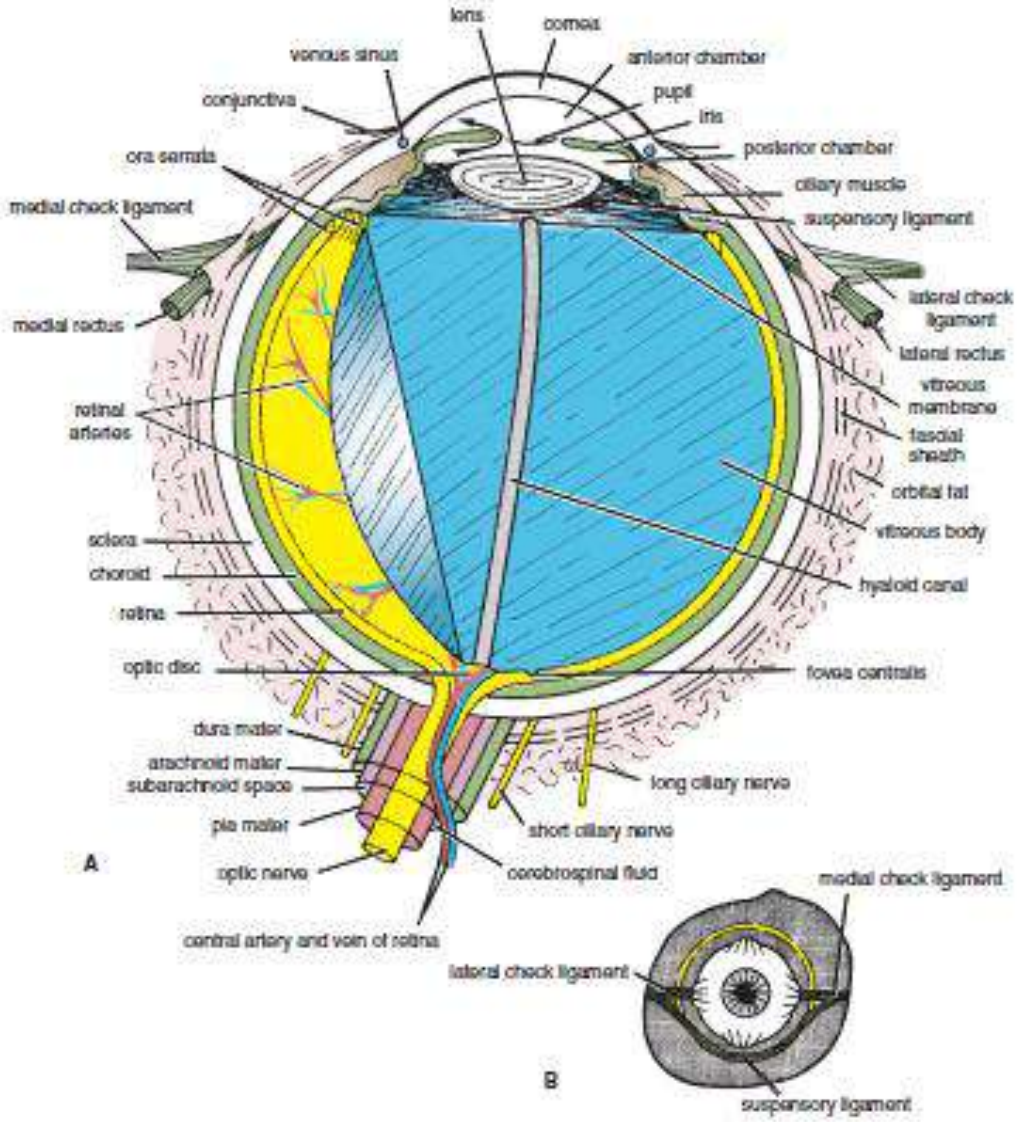
The optic nerve leaves the retina about 3 mm to the medial side of the macula lutea by the optic disc. The **optic disc** is slightly depressed at its center, where it is pierced by the **central artery of the retina.** At the optic disc is a complete absence of **rods** and **cones** so that it is insensitive to light and is referred to as the **"blind spot."** On ophthalmoscopic examination, the optic disc is seen to be pale pink in color, much paler than the surrounding retina.

Contents of the Eyeball

The contents of the eyeball consist of the refractive media, the aqueous humor, the vitreous body, and the lens.

Aqueous Humor

The aqueous humor is a clear fluid that fills the anterior and posterior chambers of the eyeball. It is believed to be a secretion from the ciliary processes, from which it enters the posterior chamber. It then flows into the anterior chamber through the pupil and is drained away through the spaces at the iridocorneal angle into the **canal of Schlemm.** Obstruction to the draining of the aqueous humor results in a rise in intraocular pressure called **glaucoma.** This can produce degenerative changes in the retina, with consequent blindness. The function of the aqueous humor is to support the wall of the eyeball by exerting internal pressure and thus maintaining its optical shape. It also nourishes the cornea and the lens and removes the products of metabolism; these functions are important because the cornea and the lens do not possess a blood supply.



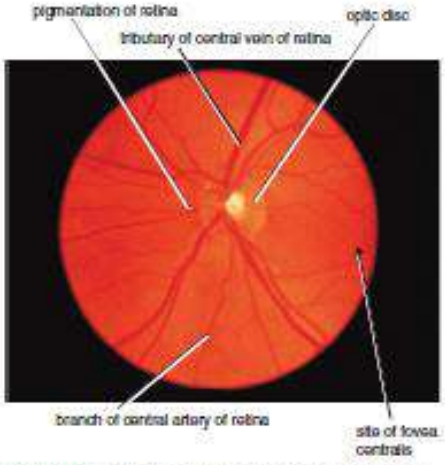


FIGURE 11.26 The left ocular fundus as seen with an ophthalmoscope.

Vitreous Body

The vitreous body fills the eyeball behind the lens and is a transparent gel. The **hyaloid canal** is a narrow channel that runs through the vitreous body from the optic disc to the posterior surface of the lens; in the fetus, it is filled by the hyaloid artery, which disappears before birth. The function of the vitreous body is to contribute slightly to the magnifying power of the eye. It supports the posterior surface of the lens and assists in holding the neural part of the retina against the pigmented part of the retina.

The Lens

The lens is a transparent, biconvex structure enclosed in a transparent capsule. It is situated behind the iris and in front of the vitreous body and is encircled by the ciliary processes. The lens consists of an elastic **capsule,** which envelops the structure; a **cuboidal epithelium,** which is confined to the anterior surface of the lens; and **lens fibers,** which are formed from the cuboidal epithelium at the equator of the lens. The lens fibers make up the bulk of the lens.

The elastic lens capsule is under tension, causing the lens constantly to endeavor to assume a globular rather than a disc shape. The equatorial region, or circumference, of the lens is attached to the ciliary processes of the ciliary body by the **suspensory ligament.** The pull of the radiating fibers of the suspensory ligament tends to keep the elastic lens flattened so that the eye can be focused on distant objects.

Accommodation of the Eye

To accommodate the eye for close objects, the ciliary muscle contracts and pulls the ciliary body forward and inward so that the radiating fibers of the suspensory ligament are relaxed. This allows the elastic lens to assume a more globular shape. With advancing age, the lens becomes denser and less elastic, and, as a result, the ability to accommodate is lessened (presbyopia). This disability can be overcome by the use of an additional lens in the form of glasses to assist the eye in focusing on nearby objects.

Constriction of the Pupil during Accommodation of the Eye

To ensure that the light rays pass through the central part of the lens so spherical aberration is diminished during accommodation for near objects, the sphincter pupillae muscle contracts so the pupil becomes smaller.

Convergence of the Eyes during Accommodation of the Lens

In humans, the retinae of both eyes focus on only one set of objects (single binocular vision). When an object moves from a distance toward an individual, the eyes converge so that a single object, not two, is seen. Convergence of the eyes results from the coordinated contraction of the medial rectus muscles.

References :

1- Snell, Richard S. Clinical anatomy by regions. Lippincott Williams & Wilkins, 2011.

2- Norton, Neil S. Netter's head and neck anatomy for dentistry e-book. Elsevier Health Sciences, 2016.

Lecture 6 The Orbit second stage

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The Orbital Region

The orbits are a pair of bony cavities that contain the eyeballs; their associated muscles, nerves, vessels, and fat; and most of the lacrimal apparatus. The orbital opening is guarded by two thin, movable folds, the eyelids.

Eyelids

The eyelids protect the eye from injury and excessive light by their closure. The upper eyelid is larger and more mobile than the lower, and they meet each other at the **medial** and **lateral angles.** The **palpebral fissure** is the elliptical opening between the eyelids and is the entrance into the conjunctival sac. When the eye is closed, the upper eyelid completely covers the cornea of the eye. When the eye is open and looking straight ahead, the upper lid just covers the upper margin of the cornea. The lower lid lies just below the cornea when the eye is open and rises only slightly when the eye is closed.

The superficial surface of the eyelids is covered by skin, and the deep surface is covered by a mucous membrane called the **conjunctiva.** The **eyelashes** are short, curved hairs on the free edges of the eyelids. They are arranged in double or triple rows at the mucocutaneous junction. The sebaceous glands (glands of Zeis) open directly into the eyelash follicles. The **ciliary glands** (glands of Moll) are modified sweat glands that open separately between adjacent lashes. The **tarsal glands** are long, modified sebaceous glands that pour their oily secretion onto the margin of the lid; their openings lie behind the eyelashes. This oily material prevents the overflow of tears and helps make the closed eyelids airtight.

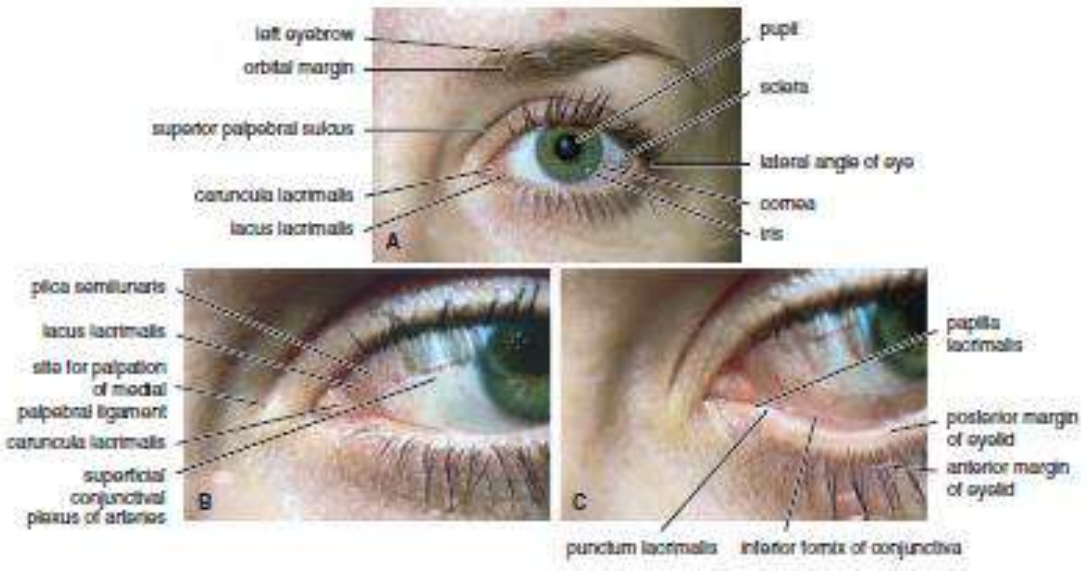
The more rounded medial angle is separated from the eyeball by a small space, the **lacus lacrimalis,** in the center of which is a small, reddish yellow elevation, the **caruncula lacrimalis**. A reddish semilunar fold, called the **plica semilunaris,** lies on the lateral side of the caruncle.

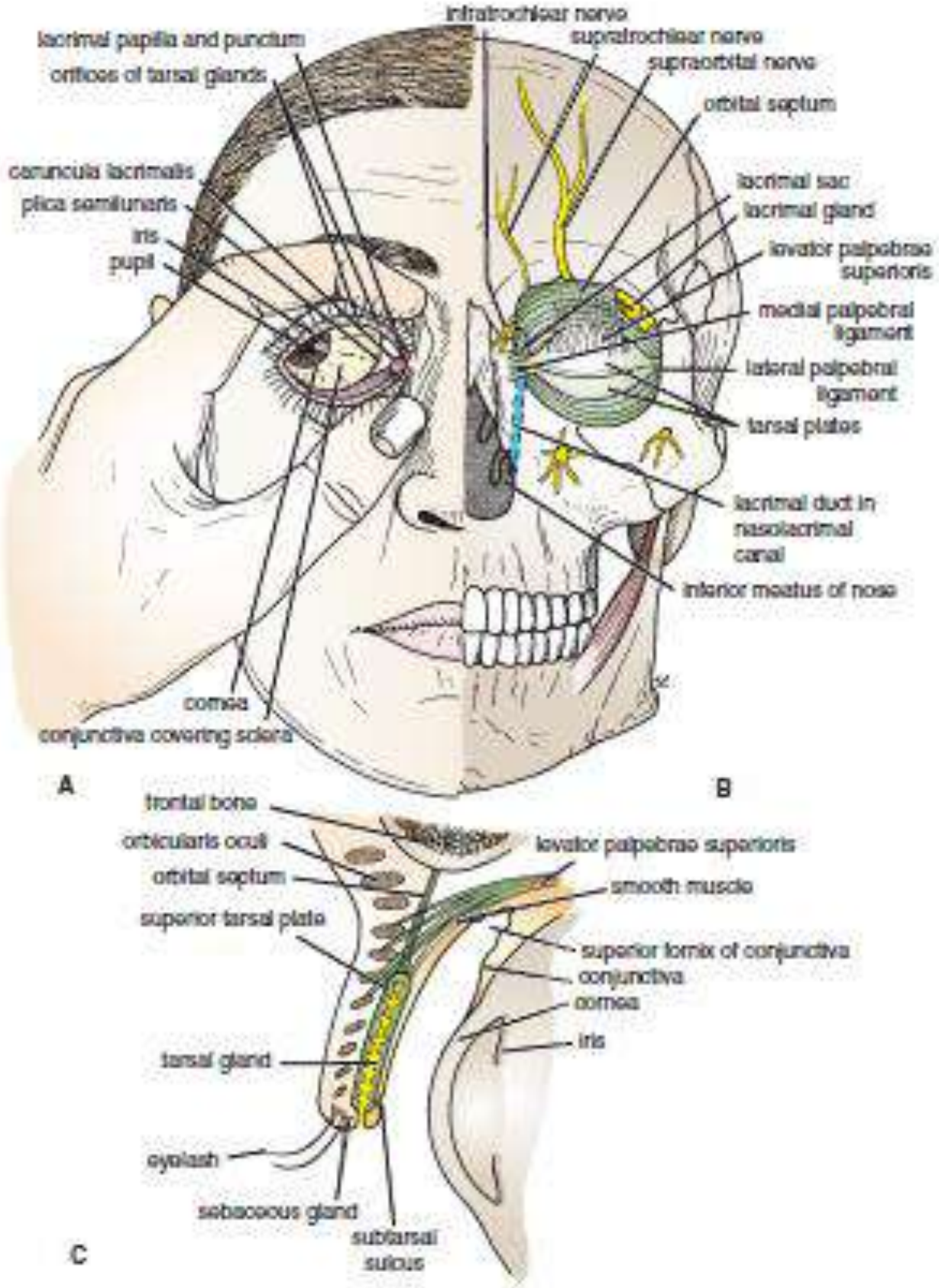
Near the medial angle of the eye a small elevation, the **papilla lacrimalis,** is present. On the summit of the papilla is a small hole, the **punctum lacrimale,**

which leads into the **canaliculus lacrimalis**. The papilla lacrimalis projects into the lacus, and the punctum and canaliculus carry tears down into the nose.

The **conjunctiva** is a thin mucous membrane that lines the eyelids and is reflected at **the superior** and **inferior fornices** onto the anterior surface of the eyeball. Its epithelium is continuous with that of the cornea. The upper lateral part of the superior fornix is pierced by the ducts of the lacrimal gland. The conjunctiva thus forms a potential space, the **conjunctival sac,** which is open at the **palpebral fissure.** Beneath the eyelid is a groove, the **subtarsal sulcus,** which runs close to and parallel with the margin of the lid. The sulcus tends to trap small foreign particles introduced into the conjunctival sac and is thus clinically important.

The framework of the eyelids is formed by a fibrous sheet, the **orbital septum.** This is attached to the periosteum at the orbital margins. The orbital septum is thickened at the margins of the lids to form the superior and inferior **tarsal plates.** The lateral ends of the plates are attached by a band, the **lateral palpebral ligament,** to a bony tubercle just within the orbital margin. The medial ends of the plates are attached by a band, the **medial palpebral ligament,** to the crest of the lacrimal bone. The tarsal glands are embedded in the posterior surface of the tarsal plates. The superficial surface of the tarsal plates and the orbital septum are covered by the palpebral fibers of the **orbicularis oculi muscle**. The aponeurosis of insertion of the **levator palpebrae superioris muscle** pierces the orbital septum to reach the anterior surface of the superior tarsal plate and the skin.




lacrimal papilla and punctum
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caruncula lacrimalis
plica semilunaris
iris
pupil
cornea
conjunctiva covering sclera
A
infratrochlear nerve
supratrochlear nerve
supraorbital nerve
orbital septum
lacrimal sac
lacrimal gland
levator palpebrae superioris
medial palpebral ligament
lateral palpebral ligament
tarsal plates
lacrimal duct in nasolacrimal canal
inferior meatus of nose
B
frontal bone
orbicularis oculi
orbital septum
superior tarsal plate
tarsal gland
eyelash
sebaceous gland
subtarsal sulcus
C
levator palpebrae superioris
smooth muscle
superior fornix of conjunctiva
conjunctiva
cornea
iris

Movements of the Eyelids

The position of the eyelids at rest depends on the tone of the **orbicularis oculi** and the **levator palpebrae superioris muscles** and the position of the eyeball. The eyelids are closed by the contraction of the orbicularis oculi and the relaxation of the levator palpebrae superioris muscles. The eye is opened by the levator palpebrae superioris raising the upper lid. On looking upward, the levator palpebrae superioris contracts, and the upper lid moves with the eyeball. On looking downward, both lids move, the upper lid continues to cover the upper part of the cornea, and the lower lid is pulled downward slightly by the conjunctiva, which is attached to the sclera and the lower lid.

TABLE 11.2 Muscles of the Eyeball and Eyelids

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Lateral rectus	Tendinous ring on posterior wall of orbital cavity	Lateral surface of eyeball just posterior to corneoscleral junction	Abducent nerve (6th cranial nerve)	Rotates eyeball so that cornea looks laterally
Superior oblique	Posterior wall of orbital cavity	Passes through pulley and is attached to superior surface of eyeball beneath superior rectus	Trochlear nerve (4th cranial nerve)	Rotates eyeball so that cornea looks downward and laterally
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Intrinsic Muscles of Eyeball (Smooth Muscle)				
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Dilator pupillae of iris			Sympathetic	Dilates pupil
Ciliary muscle			Parasympathetic via oculomotor nerve	Controls shape of lens; in accommodation, makes lens more globular
Muscles of Eyelids				
Orbicularis oculi (see Table 11.4)				
Levator palpebrae superioris	Back of orbital cavity	Anterior surface and upper margin of superior tarsal plate	Striated muscle oculomotor nerve, smooth muscle sympathetic	Raises upper lid

Lacrimal Apparatus

Lacrimal Gland

The lacrimal gland consists of a large **orbital part** and a small **palpebral part,** which are continuous with each other around the lateral edge of the aponeurosis of the levator palpebrae superioris. It is situated above the eyeball in the anterior and upper part of the orbit posterior to the orbital septum. The gland opens into the lateral part of the superior fornix of the conjunctiva by 12 ducts.

The **parasympathetic secretomotor nerve supply** is derived from the **lacrimal nucleus** of the facial nerve. The preganglionic fibers reach the pterygopalatine ganglion (sphenopalatine ganglion) via the nervus intermedius and its great petrosal branch and via the nerve of the pterygoid canal. The postganglionic fibers leave the ganglion and join the maxillary nerve. They then pass into its zygomatic branch and the zygomaticotemporal nerve. They reach the lacrimal gland within the lacrimal nerve.

The **sympathetic postganglionic nerve supply** is from the internal carotid plexus and travels in the deep petrosal nerve, the nerve of the pterygoid canal, the maxillary nerve, the zygomatic nerve, the zygomaticotemporal nerve, and finally the lacrimal nerve.

Lacrimal Ducts

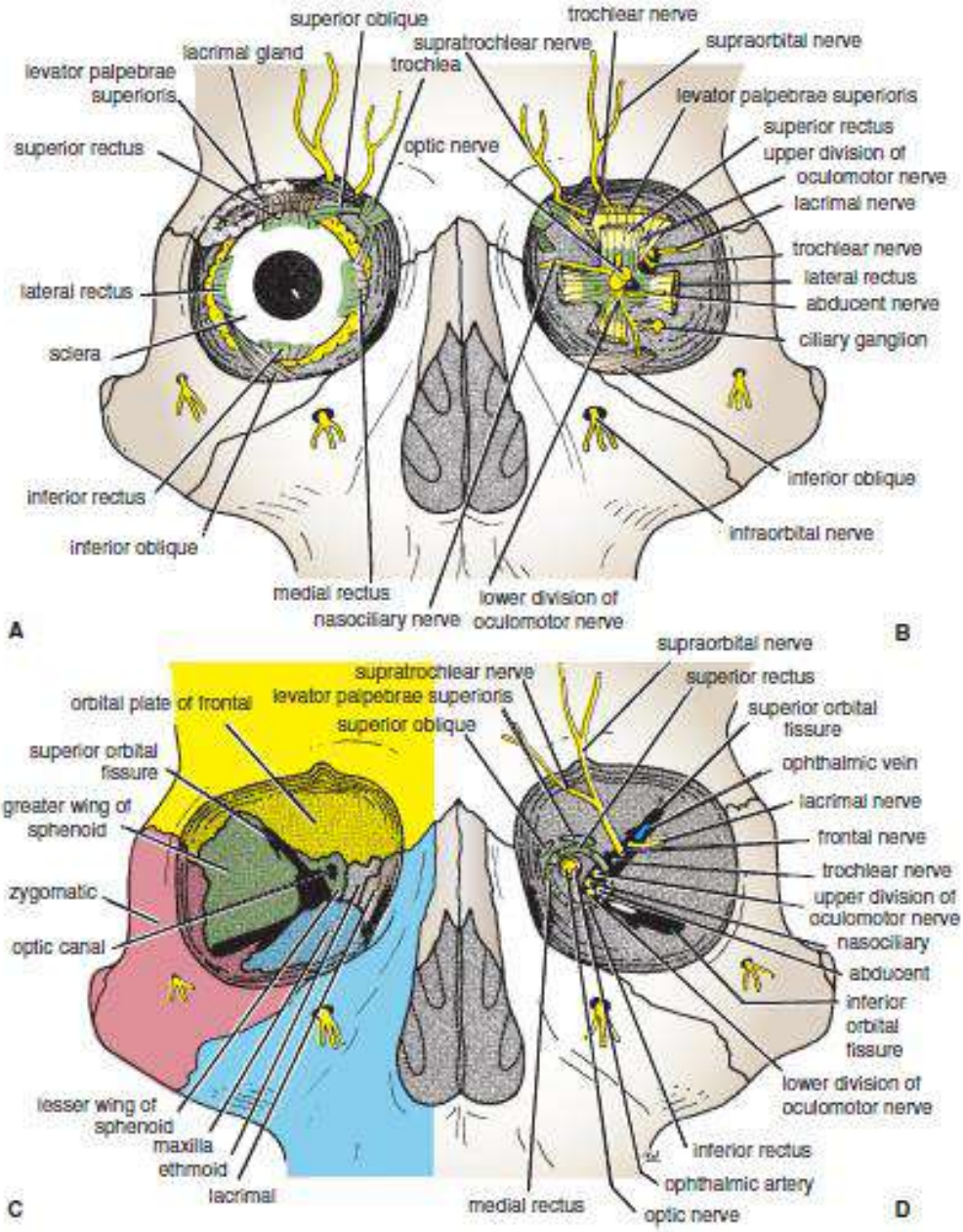
The tears circulate across the cornea and accumulate in the **lacus lacrimalis.** From here, the tears enter the **canaliculi lacrimales** through the **puncta lacrimalis.** The canaliculi lacrimales pass medially and open into the **lacrimal sac** which lies in the lacrimal groove behind the medial palpebral ligament and is the upper blind end of the nasolacrimal duct.

The **nasolacrimal duct** is about 0.5 in. (1.3 cm) long and emerges from the lower end of the lacrimal sac. The duct descends downward, backward, and laterally in a bony canal and opens into the inferior meatus of the nose. The opening is guarded by a fold of mucous membrane known as the **lacrimal fold.** This prevents air from being forced up the duct into the lacrimal sac on blowing the nose.

The Orbit

Description

The orbit is a pyramidal cavity with its base anterior and its apex posterior. The **orbital margin** is formed above by the frontal bone, the lateral margin is formed by the processes of the frontal and zygomatic bones, the inferior margin is formed by the zygomatic bone and the maxilla, and the medial margin is formed by the processes of the maxilla and the frontal bone.



Roof: Formed by the orbital plate of the frontal bone, which separates the orbital cavity from the anterior cranial fossa and the frontal lobe of the cerebral hemisphere. **Lateral wall:** Formed by the zygomatic bone and the greater wing of the sphenoid **Floor:** Formed by the orbital plate of the maxilla, which separates the orbital cavity from the maxillary sinus. **Medial wall:** Formed from before backward by the frontal process of the maxilla, the lacrimal bone, the orbital plate of the ethmoid (which separates the orbital cavity from the ethmoid sinuses), and the body of the sphenoid.

Openings into the Orbital Cavity

The openings into the orbital cavity are:

Orbital opening: Lies anteriorly. About one sixth of the eye is exposed; the remainder is protected by the walls of the orbit.

Supraorbital notch (Foramen): The supraorbital notch is situated on the superior orbital margin. It transmits the supraorbital nerve and blood vessels.

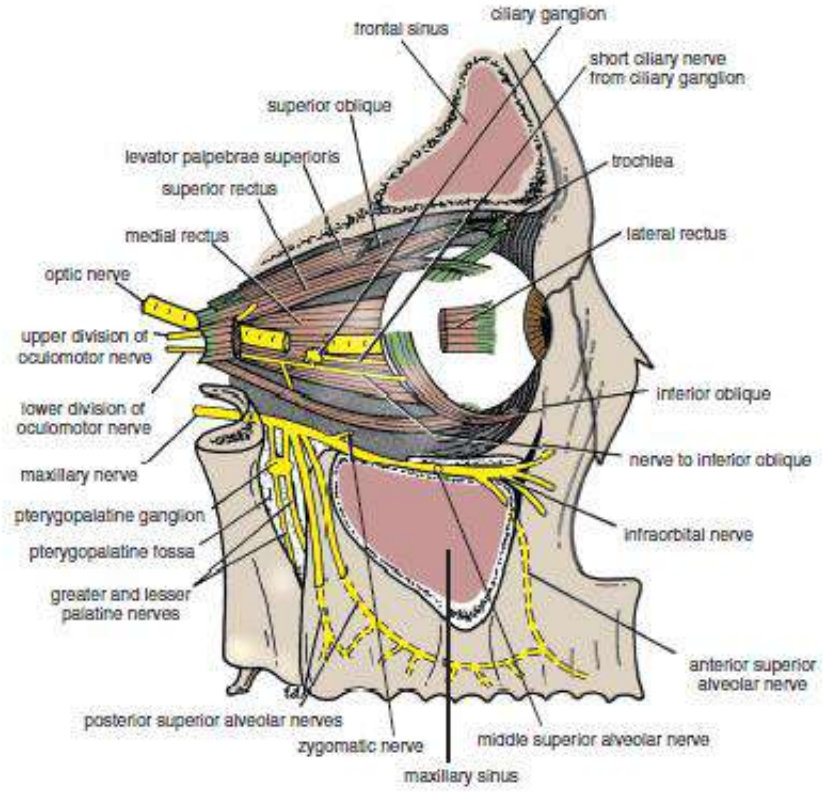
Infraorbital groove and canal: Situated on the floor of the orbit in the orbital plate of the maxilla; they transmit the infraorbital nerve (a continuation of the maxillary nerve) and blood vessels.

Nasolacrimal canal: Located anteriorly on the medial wall; it communicates with the inferior meatus of the nose. It transmits the nasolacrimal duct.

Inferior orbital fissure: Located posteriorly between the maxilla and the greater wing of the sphenoid; it communicates with the pterygopalatine fossa. It transmits the maxillary nerve and its zygomatic branch, the inferior ophthalmic vein, and sympathetic nerves.

Superior orbital fissure: Located posteriorly between the greater and lesser wings of the sphenoid; it communicates with the middle cranial fossa. It transmits the lacrimal nerve, the frontal nerve, the trochlear nerve, the oculomotor nerve (upper and lower divisions), the abducent nerve, the nasociliary nerve, and the superior ophthalmic vein.

Optic canal: Located posteriorly in the lesser wing of the sphenoid; it communicates with the middle cranial fossa. It transmits the optic nerve and the ophthalmic artery.



Orbital Fascia

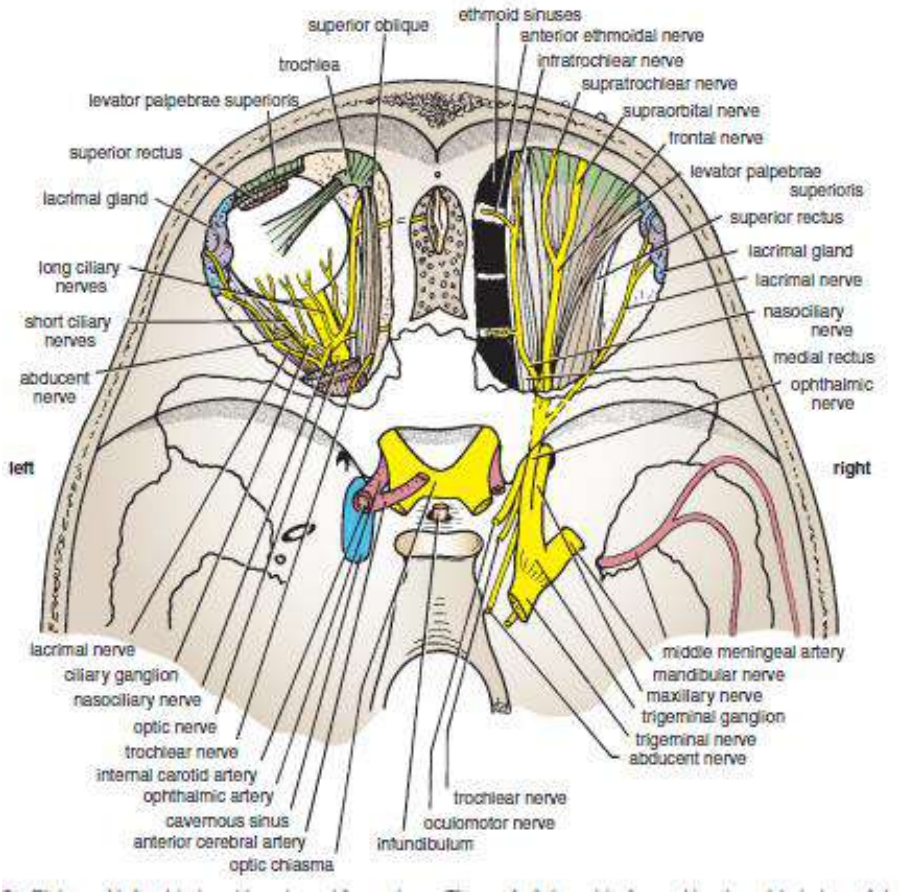
The orbital fascia is the periosteum of the bones that form the walls of the orbit. It is loosely attached to the bones and is continuous through the foramina and fissures with the periosteum covering the outer surfaces of the bones. The **muscle of Müller,** or **orbitalis muscle,** is a thin layer of smooth muscle that bridges the inferior orbital fissure. It is supplied by sympathetic nerves, and its function is unknown.

Nerves of the Orbit

Optic Nerve

The optic nerve enters the orbit from the middle cranial fossa by passing through the optic canal. It is accompanied by the ophthalmic artery, which lies on its lower lateral side. The nerve is surrounded by sheaths of pia mater, arachnoid mater, and

dura mater. It runs forward and laterally within the cone of the recti muscles and pierces the sclera at a point medial to the posterior pole of the eyeball. Here, the meninges fuse with the sclera so that the subarachnoid space with its contained cerebrospinal fluid extends forward from the middle cranial fossa, around the optic nerve, and through the optic canal, as far as the eyeball. A rise in pressure of the cerebrospinal fluid within the cranial cavity therefore is transmitted to the back of the eyeball.



Lacrimal Nerve

The lacrimal nerve arises from the ophthalmic division of the trigeminal nerve. It enters the orbit through the upper part of the superior orbital fissure and passes forward along the upper border of the lateral rectus muscle. It is joined by a branch of the zygomaticotemporal nerve, which later leaves it to enter the lacrimal gland (parasympathetic secretomotor fibers). The lacrimal nerve ends by supplying the skin of the lateral part of the upper lid.

Frontal Nerve

The frontal nerve arises from the ophthalmic division of the trigeminal nerve. It enters the orbit through the upper part of the superior orbital fissure and passes forward on the upper surface of the levator palpebrae superioris beneath the roof of the orbit. It divides into the **supratrochlear** and **supraorbital nerves** that wind around the upper margin of the orbital cavity to supply the skin of the forehead; the supraorbital nerve also supplies the mucous membrane of the frontal air sinus.

Trochlear Nerve

The trochlear nerve enters the orbit through the upper part of the superior orbital fissure. It runs forward and supplies the superior oblique muscle.

Oculomotor Nerve

The **superior ramus** of the oculomotor nerve enters the orbit through the lower part of the superior orbital fissure. It supplies the superior rectus muscle, then pierces it, and supplies the levator palpebrae superioris muscle. The **inferior ramus** of the oculomotor nerve enters the orbit in a similar manner and supplies the inferior rectus, the medial rectus, and the inferior oblique muscles. The nerve to the inferior oblique gives off a branch that passes to the ciliary ganglion and carries parasympathetic fibers to the sphincter pupillae and the ciliary muscle

Nasociliary Nerve

The nasociliary nerve arises from the ophthalmic division of the trigeminal nerve. It enters the orbit through the lower part of the superior orbital fissure. It crosses above the optic nerve, runs forward along the upper marginof the medial rectus muscle, and ends by dividing into the **anterior ethmoidal** and **infratrochlear nerves**.

Branches of the Nasociliary Nerve

■ The **communicating branch to the ciliary ganglion** is a sensory nerve. The sensory fibers from the eyeball pass to the ciliary ganglion via the short ciliary nerves, pass through the ganglion without interruption, and then join the nasociliary nerve by means of the communicating branch.

■The **long ciliary nerves,** two or three in number, arise from the nasociliary nerve as it crosses the optic nerve. They contain sympathetic fibers for the dilator pupillae muscle. The nerves pass forward with the short ciliary nerves and pierce the sclera of the eyeball. They continue forward between the sclera and the choroid to reach the iris.

■ The **posterior ethmoidal nerve** supplies the ethmoidal and sphenoidal air sinuses

■ The **infratrochlear nerve** passes forward below the pulley of the superior oblique muscle and supplies the skin of the medial part of the upper eyelid and the adjacent part of the nose.

■ The **anterior ethmoidal nerve** passes through the anterior ethmoidal foramen and enters the anterior cranial fossa on the upper surface of the cribriform plate of the ethmoid. It enters the nasal cavity through a slitlike opening alongside the crista galli. After supplying an area of mucous membrane, it appears on the face as the **external nasal branch** at the lower border of the nasal bone, and supplies the skin of the nose down as far as the tip.

Abducent Nerve

The abducent nerve enters the orbit through the lower part of the superior orbital fissure. It supplies the lateral rectus muscle.

Ciliary Ganglion

The ciliary ganglion is a parasympathetic ganglion about the size of a pinhead and situated in the posterior part of the orbit. It receives its preganglionic parasympathetic fibers from the oculomotor nerve via the nerve to the inferior oblique. The postganglionic fibers leave the ganglion in the **short ciliary nerves,** which enter the back of the eyeball and supply the sphincter pupillae and the ciliary muscle. A number of sympathetic fibers pass from the internal carotid plexus into the orbit and run through the ganglion without interruption.

Blood Vessels and Lymph Vessels of the Orbit

Ophthalmic Artery

The ophthalmic artery is a branch of the internal carotid artery after that vessel emerges from the cavernous sinus. It enters the orbit through the optic canal with the optic nerve. It runs forward and crosses the optic nerve to reach the medial wall of the orbit. It gives off numerous branches, which accompany the nerves in the orbital cavity.

Branches of the Ophthalmic Artery

■ The **central artery of the retina** is a small branch that pierces the meningeal sheaths of the optic nerve to gain entrance to the nerve. It runs in the substance of the optic nerve and enters the eyeball at the center of the **optic disc.** Here, it divides into branches, which may be studied in a patient through an ophthalmoscope. The branches are end arteries.

■ The **muscular branches**

■ The **ciliary arteries** can be divided into anterior and posterior groups. The former group enters the eyeball near the corneoscleral junction; the latter group enters near the optic nerve.

■ The **lacrimal artery** to the lacrimal gland

■ The **supratrochlear** and **supraorbital arteries** are distributed to the skin of the forehead.

Ophthalmic Veins

The **superior ophthalmic vein** communicates in front with the facial vein. The **inferior ophthalmic vein** communicates through the inferior orbital fissure with the pterygoid venous plexus. Both veins pass backward through the superior orbital fissure and drain into the cavernous sinus.

Lymph Vessels

No lymph vessels or nodes are present in the orbital cavity.

References :

1- Snell, Richard S. Clinical anatomy by regions. Lippincott Williams & Wilkins, 2011.

2- Norton, Neil S. Netter's head and neck anatomy for dentistry e-book. Elsevier Health Sciences, 2016.

Lecture 5 The Brain second stage

د.أحمد جسام النقيب

The brain is that part of the central nervous system that lies inside the cranial cavity. It is continuous with the spinal cord through the foramen magnum.

Major Parts of the Brain		Cavities of the Brain
Forebrain	Cerebrum	Right and left lateral ventricles
	Diencephalon	Third ventricle
Midbrain		Cerebral aqueduct
Hindbrain	Pons	Fourth ventricle and central canal
	Medullaoblongata	
	Cerebellum	

Cerebrum

The **cerebrum** is the largest part of the brain and consists of two **cerebral hemispheres** connected by a mass of white matter called the **corpus callosum**.

Each hemisphere extends from the frontal to the occipital bones; above the anterior and middle cranial fossae; and, posteriorly, above the tentorium cerebelli. The hemispheres are separated by a deep cleft, the **longitudinal fissure**, into which projects the **falx cerebri**.

The surface layer of each hemisphere is called the **cortex** and is composed of **gray matter**. The cerebral cortex is thrown into folds, or **gyri,** separated by fissures, **or sulci.** By this means, the surface area of the cortex is greatly increased. Several of the large sulci conveniently subdivide the surface of each hemisphere into **lobes.** The lobes are named for the bones of the cranium under which they lie.

The **frontal lobe** is situated in front of the **central sulcus** and above the **lateral sulcus.** The **parietal lobe** is situated behind the central sulcus and above the lateral sulcus. The **occipital lobe** lies below the **parietooccipital sulcus.** Below the lateral sulcus is situated the **temporal lobe.**

The **precentral gyrus** lies immediately anterior to the central sulcus and is known as the **motor area**. The large motor nerve cells in this area control voluntary movements on the opposite side of the body. Most nerve fibers cross over to the opposite side in the medulla oblongata as they descend to the spinal cord.

In the motor area, the body is represented in an inverted position, with the nerve cells controlling the movements of the feet located in the upper part and those controlling the movements of the face and hands in the lower part.

The **postcentral gyrus** lies immediately posterior to the central sulcus and is known as the **sensory area**. The small nerve cells in this area receive and interpret

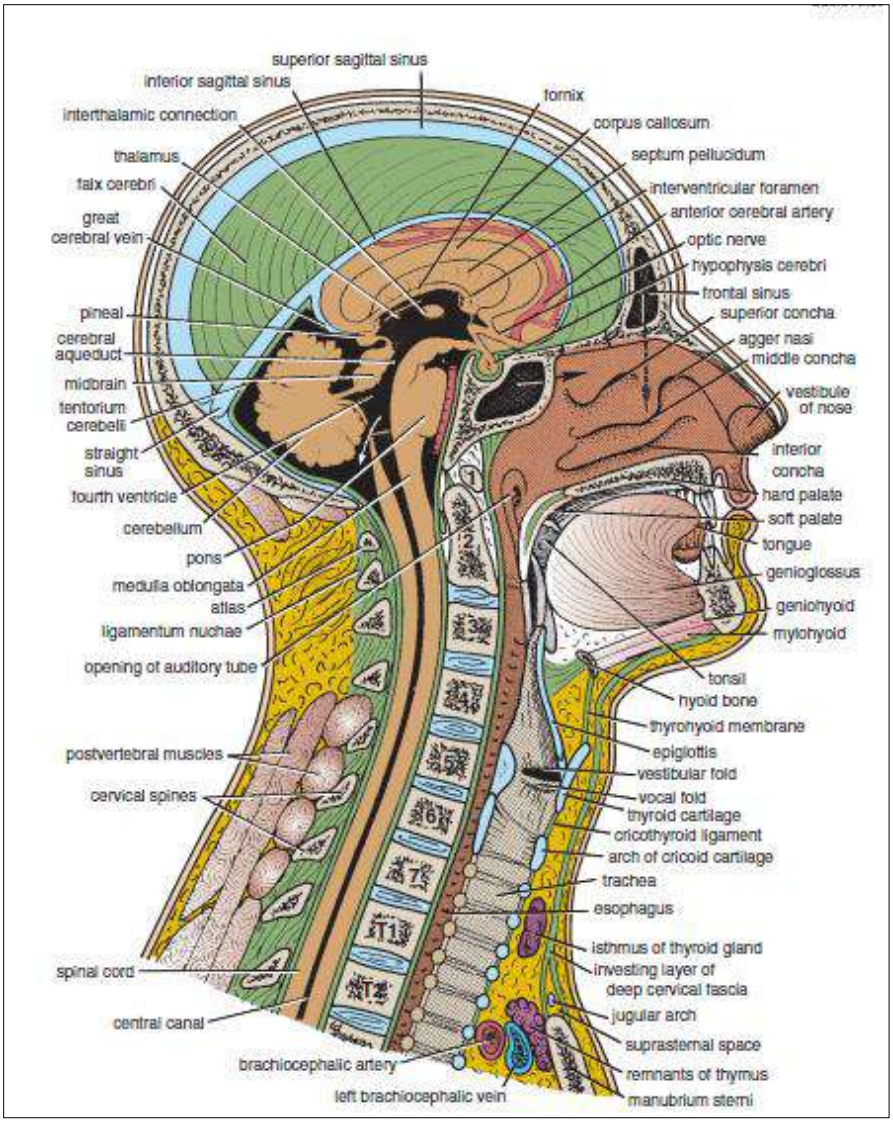
sensations of pain, temperature, touch, and pressure from the opposite side of the body.

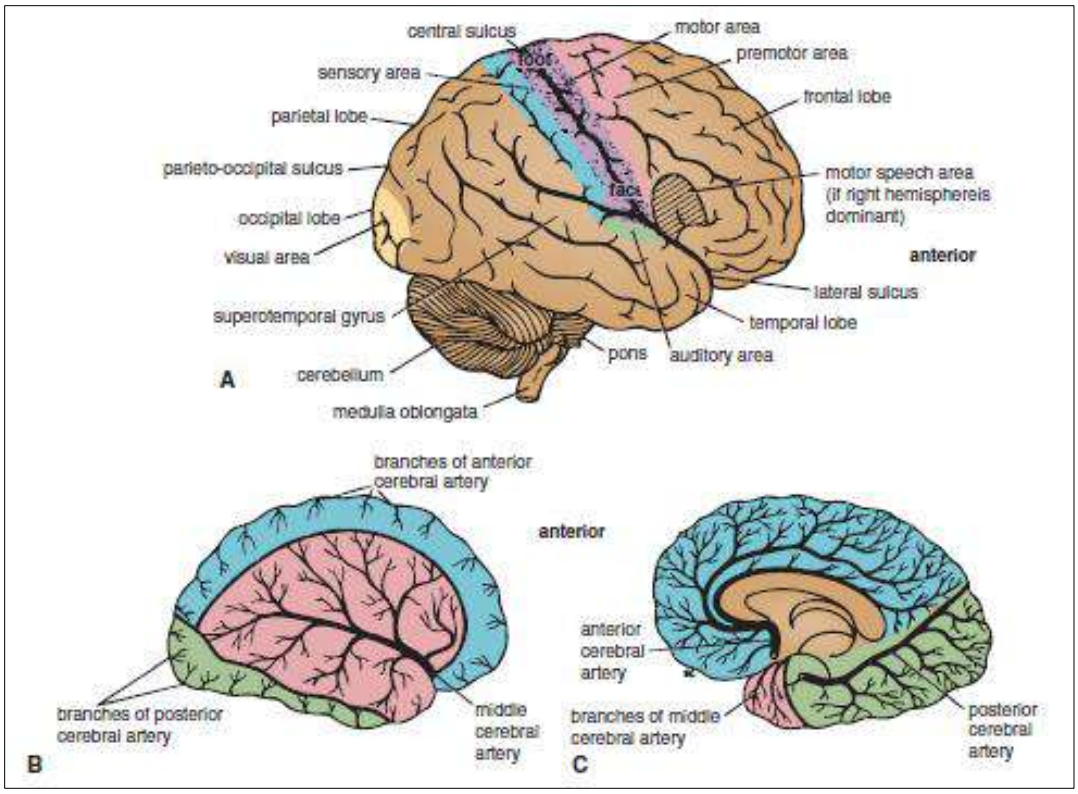
The **superior temporal gyrus** lies immediately below the lateral sulcus. The middle of this gyrus is concerned with the reception and interpretation of sound and is known as the **auditory area.**

Broca's area, or the **motor speech area,** lies just above the lateral sulcus. It controls the movements employed in speech. It is dominant in the left hemisphere in right-handed persons and in the right hemisphere in left-handed persons.

The **visual area** is situated on the posterior pole and medial aspect of the cerebral hemisphere in the region of the **calcarine sulcus**. It is the receiving area for visual impressions.

The cavity present within each cerebral hemisphere is called the **lateral ventricle.** The lateral ventricle communicate with the third ventricle through the **interventricular foramina.**





Diencephalon

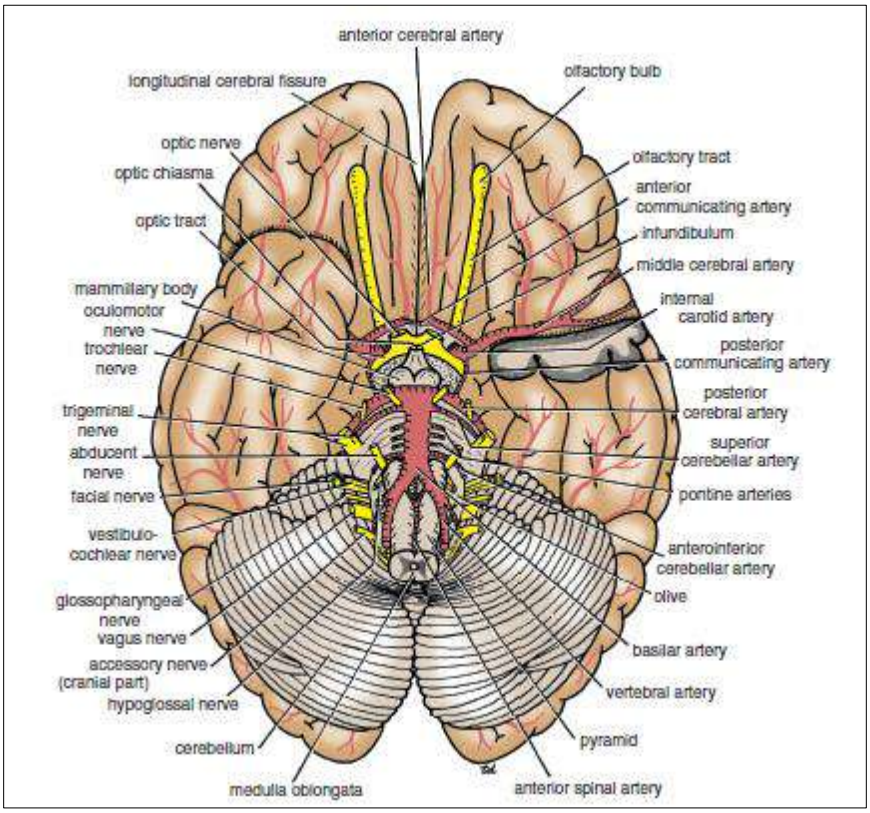
The diencephalon is almost completely hidden from the surface of the brain. It consists of a dorsal **thalamus** and a ventral **hypothalamus.** The thalamus is a large mass of gray matter that lies on either side of the third ventricle. It is the great relay station on the afferent sensory pathway to the cerebral cortex. The hypothalamus forms the lower part of the lateral wall and floor of the third ventricle. The following structures are found in the floor of the third ventricle from before backward: the **optic chiasma**, the **tuber cinereum** and the **infundibulum,** the **mammillary bodies,** and the **posterior perforated substance.**

Midbrain

The midbrain is the narrow part of the brain that passes through the tentorial notch and connects the forebrain to the hindbrain.

The midbrain comprises two lateral halves called the **cerebral peduncles;** each of these is divided into an anterior part, the **crus cerebri;** and a posterior part, the **tegmentum,** by a pigmented band of gray matter, the **substantia nigra**. The narrow cavity of the midbrain is the **cerebral aqueduct,** which connects the third and fourth ventricles. The **tectum** is the part of the midbrain posterior to the cerebral aqueduct; it has four small surface swellings, namely, the **two superior** and **two inferior colliculi.**

The colliculi are deeply placed between the cerebellum and the cerebral hemispheres. The **pineal body** is a small glandular structure that lies between the superior colliculi. It is attached by a stalk to the region of the posterior wall of the third ventricle. The pineal commonly calcifies in middle age, and thus it can be visualized on radiographs.



Hindbrain

The **pons** is situated on the anterior surface of the cerebellum below the midbrain and above the medulla oblongata. It is composed mainly of nerve fibers, which connect the two halves of the cerebellum. It also contains ascending and descending fibers connecting the forebrain, the midbrain, and the spinal cord. Some of the nerve cells within the pons serve as relay stations, whereas others form cranial nerve nuclei.

The **medulla oblongata** is conical in shape and connects the pons above to the spinal cord below. A **median fissure** is present on the anterior surface of the medulla, and on each side of this is a swelling called the **pyramid**. The pyramids are composed of bundles of nerve fibers that originate in large nerve cells in the precentral gyrus of the cerebral cortex. The pyramids taper below, and here most of the descending fibers cross over to the opposite side, forming the **decussation of the pyramids.**

Posterior to the pyramids are the **olives,** which are oval elevations produced by the underlying **olivary nuclei**. Behind the olives are the **inferior cerebellar peduncles,** which connect the medulla to the cerebellum.
On the posterior surface of the inferior part of the medulla oblongata are the **gracile** and **cuneate tubercles,** produced by the medially placed underlying **nucleus gracilis** and the laterally placed underlying **nucleus cuneatus.**
The **cerebellum** lies within the posterior cranial fossa beneath the tentorium cerebelli. It is situated posterior to the pons and the medulla oblongata. It consists of two hemispheres connected by a median portion, the **vermis.** The cerebellum is connected to the midbrain by the **superior cerebellar peduncles,** to the pons by the **middle cerebellar peduncles,** and to the medulla by the **inferior cerebellar peduncles.**
The surface layer of each cerebellar hemisphere, called the **cortex,** is composed of gray matter. The cerebellar cortex is thrown into folds, or **folia,** separated by closely set transverse fissures. Certain masses of gray matter are found in the interior of the cerebellum, embedded in the white matter; the largest of these is known as the **dentate nucleus.**
The cerebellum plays an important role in the control of muscle tone and the coordination of muscle movement on the same side of the body.
The cavity of the hindbrain is the fourth ventricle. This is bounded in front by the pons and the medulla oblongata and behind by the **superior** and **inferior medullary vela** and the cerebellum. The fourth ventricle is connected above to the third ventricle by the cerebral aqueduct, and below it is continuous with the central canal of the spinal cord. It communicates with the subarachnoid space through three openings in the lower part of the roof: a median and two lateral openings.

Ventricles of the Brain

The ventricles of the brain consist of the two lateral ventricles, the third ventricle, and the fourth ventricle. The two **lateral ventricles** communicate with the **third ventricle** through the **interventricular foramina**; the third ventricle communicates with the fourth ventricle by the **cerebral aqueduct.** The fourth ventricle, in turn, is continuous with the narrow **central canal** of the spinal cord and, through the three foramina in its roof, with the subarachnoid space. The ventricles are filled with cerebrospinal fluid, which is produced by the **choroid plexuses** of the two lateral ventricles, the third ventricle, and the fourth ventricle. The size and shape of the cerebral ventricles may be visualized clinically using computed tomography (CT) scans and magnetic resonance imaging (MRI).

Blood Supply of the Brain

Arteries of the Brain

The brain is supplied by the two internal carotid and the two vertebral arteries. The four arteries anastomose on the inferior surface of the brain and form the **circle of Willis** (circulus arteriosus).

Veins of the Brain

The veins of the brain have no muscular tissue in their thin walls, and they possess no valves. They emerge from the brain and drain into the cranial venous sinuses.
Cerebral and cerebellar veins and veins of the brainstem are present. The **great cerebral vein** is formed by the union of the two **internal cerebral veins** and drains into the straight sinus.

The Cranial Nerves in the Cranial Cavity

The 12 pairs of cranial nerves are named as follows:
I. Olfactory (sensory)
II. Optic (sensory)
III. Oculomotor (motor)
IV. Trochlear (motor)
V. Trigeminal (mixed)
VI. Abducent (motor)
VII. Facial (mixed)
VIII. Vestibulocochlear (sensory)
IX. Glossopharyngeal (mixed)
X. Vagus (mixed)
XI. Accessory (motor)
XII. Hypoglossal (motor)

The nerves emerge from the brain and are transmitted through foramina and fissures in the base of the skull. All the nerves are distributed in the head and neck except the vagus, which also supplies structures in the thorax and abdomen. The olfactory, optic, and vestibulocochlear nerves are entirely sensory; the oculomotor, trochlear, abducent, accessory, and hypoglossal nerves are entirely motor; and the remaining nerves are mixed.

References :

1- Snell, Richard S. Clinical anatomy by regions. Lippincott Williams & Wilkins, 2011.

2- Norton, Neil S. Netter's head and neck anatomy for dentistry e-book. Elsevier Health Sciences, 2016.

The Meninges

The brain in the skull is surrounded by three protective membranes, or meninges: the dura mater, the arachnoid mater, and the pia mater. (The spinal cord in the vertebral column is also surrounded by three meninges)

Dura Mater of the Brain

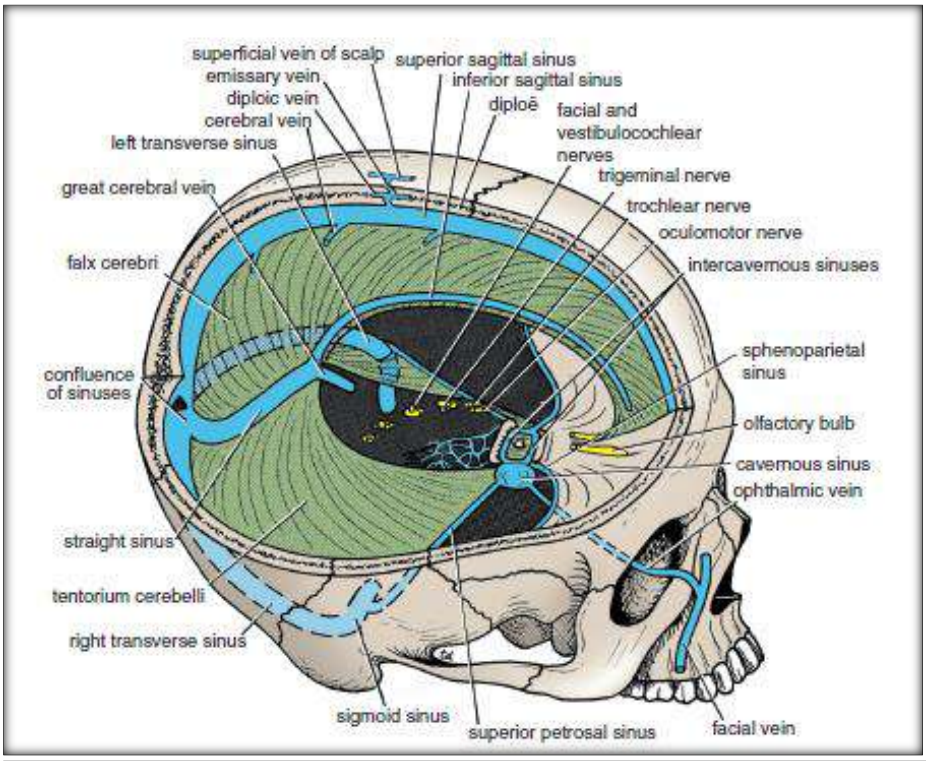
The dura mater is conventionally described as two layers: the endosteal layer and the meningeal layer. These are closely united except along certain lines, where they separate to form venous sinuses. The **endosteal layer** is nothing more than the ordinary periosteum covering the inner surface of the skull bones. **It does not extend** through the foramen magnum to become continuous with the dura mater of the spinal cord. Around the margins of all the foramina in the skull, it becomes continuous with the periosteum on the outside of the skull bones. At the sutures, it is continuous with the sutural ligaments. It is most strongly adherent to the bones over the base of the skull.

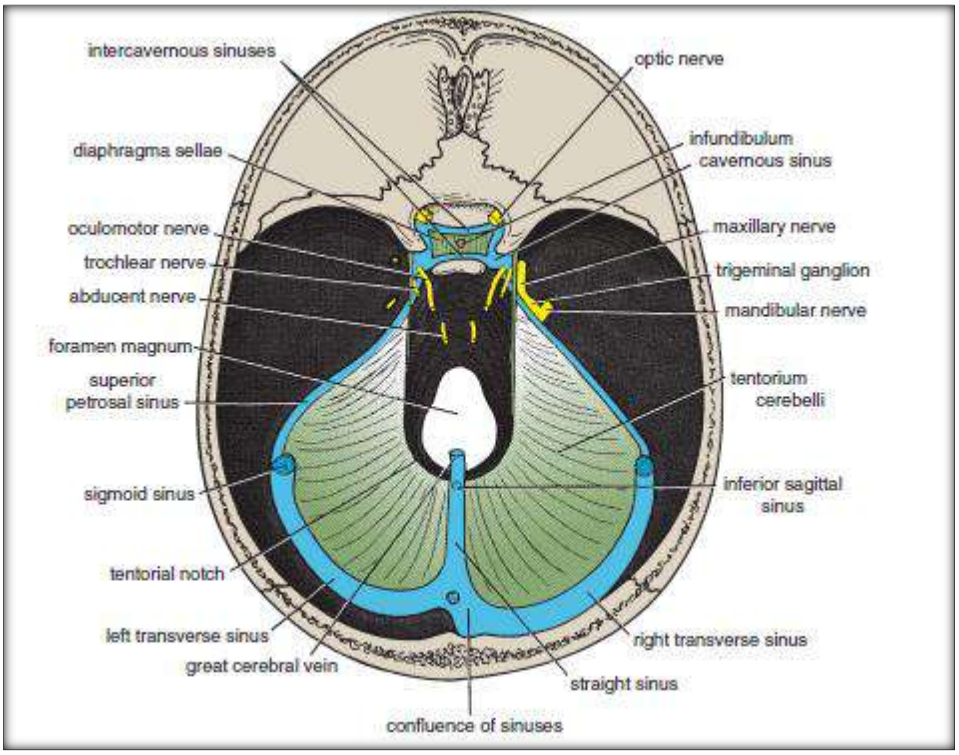
The **meningeal layer** is the dura mater proper. It is a dense, strong, fibrous membrane covering the brain and is continuous through the foramen magnum with the dura mater of the spinal cord. It provides tubular sheaths for the cranial nerves as the latter pass through the foramina in the skull. Outside the skull, the sheaths fuse with the epineurium of the nerves. The meningeal layer sends inward four septa that divide the cranial cavity into freely communicating spaces lodging the subdivisions of the brain. The function of these septa is to restrict the rotatory displacement of the brain.

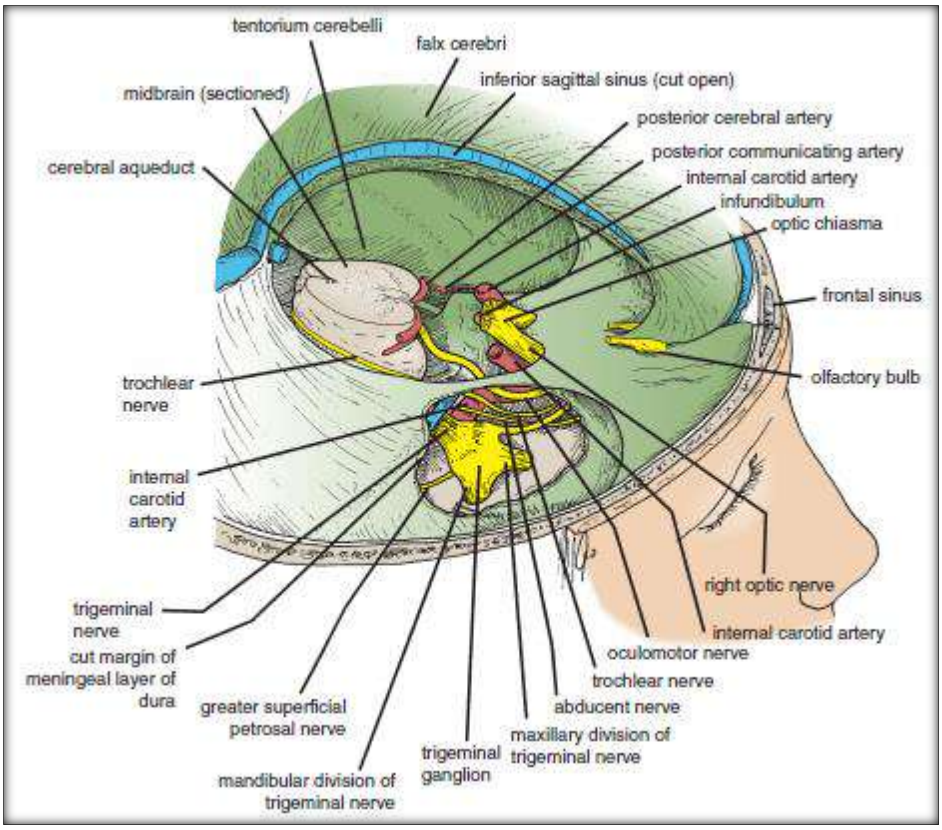
The **falx cerebri** is a sickle-shaped fold of dura mater that lies in the midline between the two cerebral hemispheres. Its narrow end in front is attached to the internal frontal crest and the crista galli. Its broad posterior part blends in the midline with the upper surface of the tentorium cerebelli. The superior sagittal sinus runs in its upper fixed margin, the inferior sagittal sinus runs in its lower concave free margin, and the straight sinus runs along its attachment to the tentorium cerebelli.

The **tentorium cerebelli** is a crescent-shaped fold of dura mater that roofs over the posterior cranial fossa. It covers the upper surface of the cerebellum and supports the occipital lobes of the cerebral hemispheres. In front is a gap, the **tentorial notch,** for the passage of the midbrain, thus producing an inner free border and an outer attached or fixed border. The fixed border is attached to the posterior clinoid processes, the superior borders of the petrous bones, and the margins of the grooves for the transverse sinuses on the occipital bone. The free

border runs forward at its two ends, crosses the attached border, and is affixed to the anterior clinoid process on each side. At the point where the two borders cross, the third and fourth cranial nerves pass forward to enter the lateral wall of the cavernous sinus







Close to the apex of the petrous part of the temporal bone, the lower layer of the tentorium is pouched forward beneath the superior petrosal sinus to form a recess for the trigeminal nerve and the trigeminal ganglion.

The falx cerebri and the falx cerebelli are attached to the upper and lower surfaces of the tentorium, respectively. The straight sinus runs along its attachment to the falx cerebri, the superior petrosal sinus along its attachment to the petrous bone, and the transverse sinus along its attachment to the occipital bone.

The **falx cerebelli** is a small, sickle-shaped fold of dura mater that is attached to the internal occipital crest and projects forward between the two cerebellar hemispheres. Its posterior fixed margin contains the occipital sinus.

The **diaphragma sellae** is a small circular fold of dura mater that forms the roof for the sella turcica. A small opening in its center allows passage of the stalk of the pituitary gland.

Dural Nerve Supply

Branches of the trigeminal, vagus, and first three cervical nerves and branches from the sympathetic system pass to the dura. Numerous sensory endings are in the dura. The dura is sensitive to stretching, which produces the sensation of headache. Stimulation of the sensory endings of the trigeminal nerve above the level of the tentorium cerebelli produces referred pain to an area of skin on the same side of the

head. Stimulation of the dural endings below the level of the tentorium produces referred pain to the back of the neck and back of the scalp along the distribution of the greater occipital nerve.

Dural Arterial Supply

Numerous arteries supply the dura mater from the internal carotid, maxillary, ascending pharyngeal, occipital, and vertebral arteries. From a clinical standpoint, the most important is the middle meningeal artery, which is commonly damaged in head injuries.

The **middle meningeal artery** arises from the maxillary artery in the infratemporal fossa. It enters the cranial cavity and runs forward and laterally in a groove on the upper surface of the squamous part of the temporal bone. To enter the cranial cavity, it passes through the foramen spinosum to **lie between the meningeal and endosteal layers of dura.** The anterior (frontal) branch deeply grooves or tunnels the anteroinferior angle of the parietal bone, and its course corresponds roughly to the line of the underlying precentral gyrus of the brain. The posterior (parietal) branch curves backward and supplies the posterior part of the dura mater.

Dural Venous Drainage

The **meningeal veins** lie in the endosteal layer of dura. The middle meningeal vein follows the branches of the middle meningeal artery and drains into the pterygoid venous plexus or the sphenoparietal sinus. The veins lie lateral to the arteries.

Arachnoid Mater of the Brain

The arachnoid mater is a delicate, impermeable membrane covering the brain and lying between the pia mater internally and the dura mater externally. It is separated from the dura by a potential space, the **subdural space,** and from the pia by the **subarachnoid space,** which is filled with **cerebrospinal fluid.**

The arachnoid bridges over the sulci on the surface of the brain, and in certain situations the arachnoid and pia are widely separated to form the **subarachnoid cisternae.**

In certain areas, the arachnoid projects into the venous sinuses to form **arachnoid villi.** The arachnoid villi are most numerous along the superior sagittal sinus. Aggregations of arachnoid villi are referred to as **arachnoid granulations**. Arachnoid villi serve as sites where the cerebrospinal fluid diffuses into the bloodstream.

It is important to remember that structures passing to and from the brain to the skull or its foramina must pass

through the subarachnoid space. All the cerebral arteries and veins lie in the space, as do the cranial nerves. The arachnoid fuses with the epineurium of the nerves at

their point of exit from the skull. In the case of the optic nerve, the arachnoid forms a sheath for the nerve that extends into the orbital cavity through the optic canal and fuses with the sclera of the eyeball. Thus, the subarachnoid space extends around the optic nerve as far as the eyeball.

The **cerebrospinal fluid** is produced by the **choroid plexuses** within the lateral, third, and fourth ventricles of the brain. It escapes from the ventricular system of the brain through the three foramina in the roof of the fourth ventricle and so enters the subarachnoid space. It now circulates both upward over the surfaces of the cerebral hemispheres and downward around the spinal cord. The spinal subarachnoid space extends down as far as the **second sacral vertebra**. Eventually, the fluid enters the bloodstream by passing into the arachnoid villi and diffusing through their walls.

In addition to removing waste products associated with neuronal activity, the cerebrospinal fluid provides a fluid medium in which the brain floats. This mechanism effectively protects the brain from trauma.

Pia Mater of the Brain

The pia mater is a vascular membrane that closely invests the brain, covering the gyri and descending into the deepest sulci. It extends over the cranial nerves and fuses with their epineurium. The cerebral arteries entering the substance of the brain carry a sheath of pia with them.

The Venous Blood Sinuses

The venous sinuses of the cranial cavity are blood-filled spaces situated between the layers of the dura mater; they are lined by endothelium. Their walls are thick and composed of fibrous tissue; they have no muscular tissue. The sinuses have no valves. They receive tributaries from the brain, the diploë of the skull, the orbit, and the internal ear.

The **superior sagittal sinus** lies in the upper fixed border of the falx cerebri. It runs backward and becomes continuous with the right transverse sinus. The sinus communicates on each side with the **venous lacunae.** Numerous arachnoid villi and granulations project into the lacunae. The superior sagittal sinus receives the **superior cerebral veins.**

The **inferior sagittal sinus** lies in the free lower margin of the falx cerebri. It runs backward and joins the great cerebral vein to form the straight sinus. It receives cerebral veins from the medial surface of the cerebral hemisphere.

The **straight sinus** lies at the junction of the falx cerebri with the tentorium cerebelli. Formed by the union of the inferior sagittal sinus with the great cerebral vein, it drains into the left transverse sinus.

The **right transverse sinus** begins as a continuation of the superior sagittal sinus; the **left transverse sinus** is usually a continuation of the straight sinus. Each sinus lies in the lateral attached margin of the tentorium cerebelli, and they end on each side by becoming the sigmoid sinus.
The **sigmoid sinuses** are a direct continuation of the transverse sinuses. Each sinus turns downward behind the mastoid antrum of the temporal bone and then leaves the skull through the jugular foramen to become the internal jugular vein.
The **occipital sinus** lies in the attached margin of the falx cerebelli. It communicates with the vertebral veins through the foramen magnum and the transverse sinuses.
Each **cavernous sinus** lies on the lateral side of the body of the sphenoid bone. Anteriorly, the sinus receives the inferior ophthalmic vein and the central vein of the retina. The sinus drains posteriorly into the transverse sinus through the superior petrosal sinus. Intercavernous sinuses connect the two cavernous sinuses through the sella turcica.(see figures above)

Important Structures Associated with the Cavernous Sinuses

- The internal carotid artery and the 6th cranial nerve, which travel through it
- In the lateral wall, the 3rd and 4th cranial nerves, and the ophthalmic and maxillary divisions of the 5th cranial nerve.
- The pituitary gland, which lies medially in the sella turcica
- The veins of the face, which are connected with the cavernous sinus via the facial vein and inferior ophthalmic vein, are an important route for the spread of infection from the face
- The **superior** and **inferior petrosal sinuses,** which run along the upper and lower borders of the petrous part of the temporal bone

Pituitary Gland (Hypophysis Cerebri)

The pituitary gland is a small, oval structure attached to the undersurface of the brain by the **infundibulum**. The gland is well protected by virtue of its location in the sella turcica of the sphenoid bone. The pituitary gland is vital to life and well described later.

References :

1- Snell, Richard S. Clinical anatomy by regions. Lippincott Williams & Wilkins, 2011.

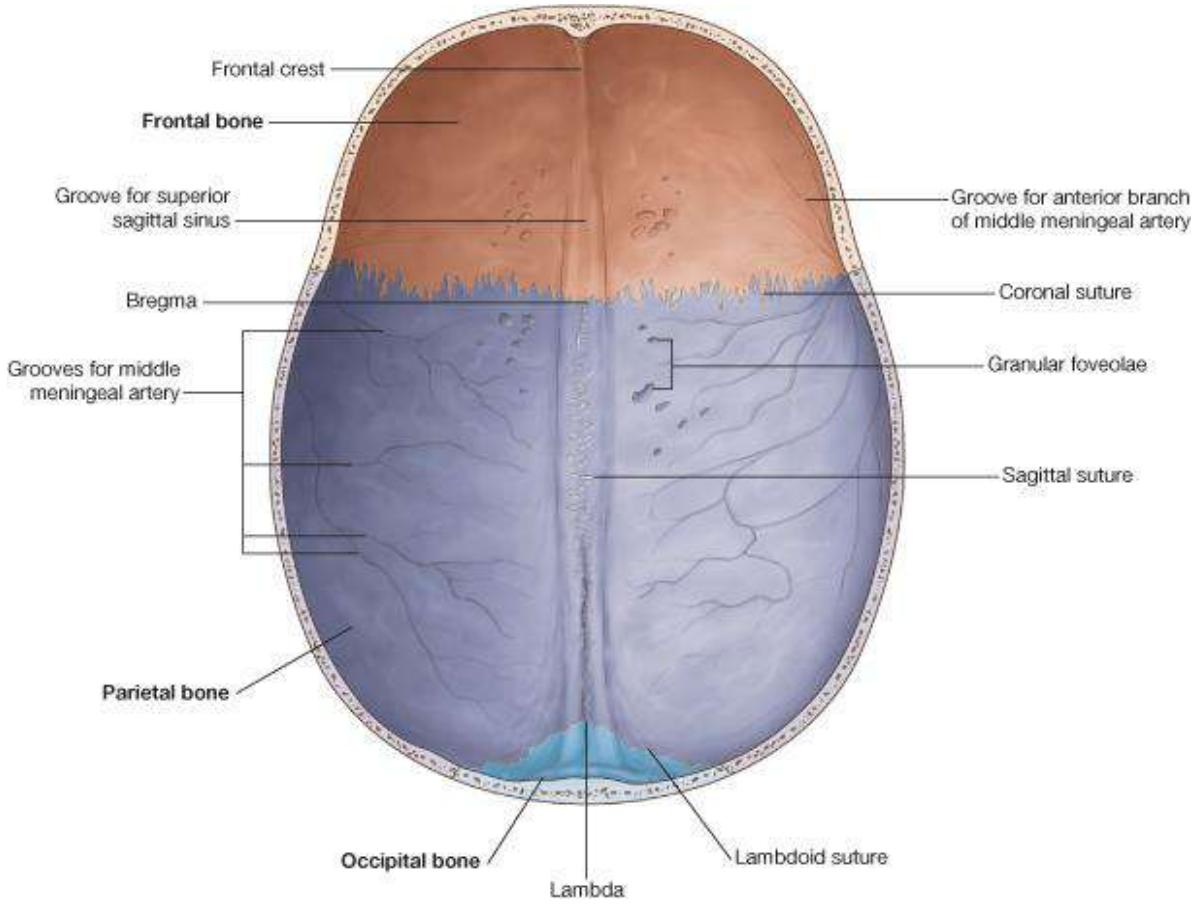
2- Norton, Neil S. Netter's head and neck anatomy for dentistry e-book. Elsevier Health Sciences, 2016.

The Cranial Cavity

The cranial cavity contains the brain and its surrounding meninges, portions of the cranial nerves, arteries, veins, and venous sinuses.

Vault of the Skull

The internal surface of the vault shows the coronal, sagittal, and lambdoid sutures. In the midline is a shallow sagittal groove that lodges the **superior sagittal sinus.** On each side of the groove are several small pits, called **granular pits,** which lodge the **lateral lacunae** and **arachnoid granulations**. Several narrow grooves are present for the anterior and posterior divisions of the **middle meningeal vessels** as they pass up the side of the skull to the vault.



Base of the Skull

The interior of the base of the skull is divided into three cranial fossae: anterior, middle, and posterior. The anterior cranial fossa is separated from the middle cranial fossa by the lesser wing of the sphenoid, and the middle cranial fossa is separated from the posterior cranial fossa by the petrous part of the temporal bone.

Anterior Cranial Fossa

The anterior cranial fossa lodges the frontal lobes of the cerebral hemispheres. It is bounded anteriorly by the inner surface of the frontal bone, and in the midline is a crest for the attachment of the **falx cerebri.** Its posterior boundary is the sharp lesser wing of the sphenoid, which articulates laterally with the frontal bone and meets the anteroinferior angle of the parietal bone, or the pterion. The medial end of the lesser wing of the sphenoid forms the **anterior clinoid process** on each side, which gives attachment to the **tentorium cerebelli.** The median part of the anterior cranial fossa is limited posteriorly by the groove for the optic chiasma. The floor of the fossa is formed by the ridged orbital plates of the frontal bone laterally and by the **cribriform plate** of the ethmoid medially. The **crista galli** is a sharp upward projection of the ethmoid bone in the midline for the attachment of the falx cerebri. Alongside the crista galli is a narrow slit in the cribriform plate for the passage of the **anterior ethmoidal nerve** into the nasal
cavity. The upper surface of the cribriform plate supports the olfactory bulbs, and the small perforations in the cribriform plate are for the **olfactory nerves.**

Middle Cranial Fossa

The middle cranial fossa consists of a small median part and expanded lateral parts. The median raised part is formed by the body of the sphenoid, and the expanded lateral parts form concavities on either side, which lodge the **temporal lobes** of the **cerebral hemispheres.** It is bounded anteriorly by the lesser wings of the sphenoid and posteriorly by the superior borders of the petrous parts of the temporal bones. Laterally lie the squamous parts of the temporal bones, the greater wings of the sphenoid, and the parietal bones. The floor of each lateral part of the middle cranial fossa is formed by the greater wing of the sphenoid and the squamous and petrous parts of the temporal bone.

The sphenoid bone resembles a bat having a centrally placed **body** with **greater** and **lesser wings** that are outstretched on each side. The body of the sphenoid contains the **sphenoid air sinuses,** which are lined with mucous membrane and communicate with the nasal cavity; they serve as voice resonators. Anteriorly, the **optic canal** transmits the optic nerve and the ophthalmic artery, a branch of the internal carotid artery, to the orbit. The **superior orbital fissure,** which is a slitlike opening between the lesser and the greater wings of the sphenoid, transmits the lacrimal, frontal, trochlear, oculomotor,
nasociliary, and abducent nerves, together with the superior ophthalmic vein. The sphenoparietal venous sinus runs medially along the posterior border of the lesser wing of the sphenoid and drains into the cavernous sinus. The **foramen rotundum,** which is situated behind the medial end of the superior orbital fissure, perforates the greater wing of the sphenoid and transmits the maxillary nerve from the trigeminal ganglion to the pterygopalatine fossa. The **foramen ovale** lies posterolateral to the foramen rotundum. It perforates the greater wing of the sphenoid and transmits the large sensory root and small motor root of the mandibular nerve to the infratemporal

fossa; the lesser petrosal nerve also passes through it. The small **foramen spinosum** lies posterolateral to the foramen ovale and also perforates the greater wing of the sphenoid. The foramen transmits the middle meningeal artery from the infratemporal fossa into the cranial cavity. The artery then runs forward and laterally in a groove on the upper surface of the squamous part of the temporal bone and the greater wing of the sphenoid. After a short distance, the artery divides into anterior and posterior branches. The anterior branch passes forward and upward to the anteroinferior angle of the parietal bone. Here, the bone is deeply grooved or tunneled by the artery for a short distance before it runs backward and upward on the parietal bone. It is at this site that the artery may be damaged after a blow to the side of the head. The posterior branch passes backward and upward across the squamous part of the temporal bone to reach the parietal bone. The large and irregularly shaped **foramen lacerum** lies between the apex of the petrous part of the temporal bone and the sphenoid bone. The inferior opening of the foramen lacerum in life is filled by cartilage and fibrous tissue, and only small blood vessels pass through this tissue from the cranial cavity to the neck. The **carotid canal** opens into the side of the foramen lacerum above the closed inferior opening. The internal carotid artery enters the foramen through the carotid canal and immediately turns upward to reach the side of the body of the sphenoid bone. Here, the artery turns forward in the cavernous sinus to reach the region of the anterior clinoid process. At this point, the internal carotid artery turns vertically upward, medial to the anterior clinoid process, and emerges from the cavernous sinus. Lateral to the foramen lacerum is an impression on the apex of the petrous part of the temporal bone for the **trigeminal ganglion.**

On the anterior surface of the petrous bone are two grooves for nerves; the largest medial groove is for the **greater petrosal nerve,** a branch of the facial nerve; the smaller lateral groove is for the **lesser petrosal nerve,** a branch of the tympanic plexus. The greater petrosal nerve enters the foramen lacerum deep to the trigeminal ganglion and joins the **deep petrosal nerve** (sympathetic fibers from around the internal carotid artery), to form the **nerve of the pterygoid canal.** The lesser petrosal nerve passes forward to the foramen ovale. The abducent nerve bends sharply forward across the apex of the petrous bone, medial to the trigeminal ganglion. Here, it leaves the posterior cranial fossa and enters the cavernous sinus. The **arcuate eminence** is a rounded eminence found on the anterior surface of the petrous bone and is caused by the underlying **superior semicircular canal.** The **tegmen tympani,** a thin plate of bone, is a forward extension of the petrous part of the temporal bone and adjoins the squamous part of the bone . From behind forward, it forms the roof of the mastoid antrum, the tympanic cavity, and the auditory tube. This thin plate of bone is the only major barrier that separates infection in the tympanic cavity from the temporal lobe of the cerebral hemisphere.

The median part of the middle cranial fossa is formed by the body of the sphenoid bone. In front is the **sulcus chiasmatis,** which is related to the optic chiasma and leads laterally to the **optic canal** on each side. Posterior to the sulcus is an elevation,

the **tuberculum sellae.** Behind the elevation is a deep depression, the **sella turcica,** which lodges the **pituitary gland.** The sella turcica is bounded posteriorly by a square plate of bone called the **dorsum sellae.** The superior angles of the dorsum sellae have two tubercles, called the **posterior clinoid processes,** which give attachment to the fixed margin of the tentorium cerebelli. The cavernous sinus is directly related to the side of the body of the sphenoid. It carries in its lateral wall the 3rd and 4th cranial nerves and the ophthalmic and maxillary divisions of the 5th cranial nerve. The internal carotid artery and the 6th cranial nerve pass forward through the sinus.

Posterior Cranial Fossa

The posterior cranial fossa is deep and lodges the parts of the hindbrain, namely, the **cerebellum, pons,** and **medulla oblongata.** Anteriorly, the fossa is bounded by the superior border of the petrous part of the temporal bone, and posteriorly it is bounded by the internal surface of the squamous part of the occipital bone. The floor of the posterior fossa is formed by the basilar, condylar, and squamous parts of the occipital bone and the mastoid part of the temporal bone.

The roof of the fossa is formed by a fold of dura, the **tentorium cerebelli,** which intervenes between the cerebellum below and the occipital lobes of the cerebral hemispheres above.

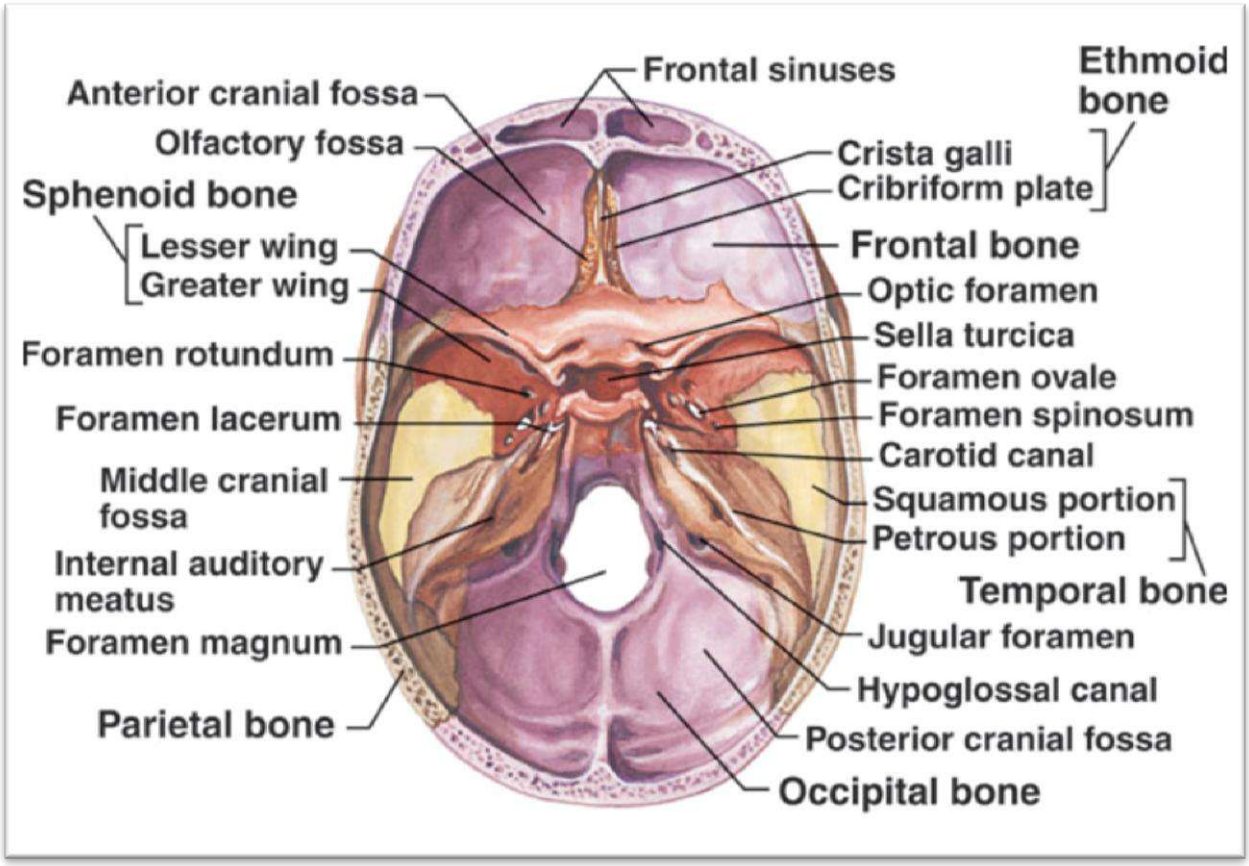
The **foramen magnum** occupies the central area of the floor and transmits the medulla oblongata and its surrounding meninges, the ascending spinal parts of the accessory nerves, and the two vertebral arteries.

The **hypoglossal canal** is situated above the anterolateral boundary of the foramen magnum and transmits the **hypoglossal nerve.** The **jugular foramen** lies between the lower border of the petrous part of the temporal bone and the condylar part of the occipital bone. It transmits the following structures from before backward: the **inferior petrosal sinus;** the **9th, 10th,** and **11th cranial nerves;** and the large **sigmoid**
sinus. The inferior petrosal sinus descends in the groove on the lower border of the petrous part of the temporal bone to reach the foramen. The sigmoid sinus turns down through the foramen to become the **internal jugular vein.** The **internal acoustic meatus** pierces the posterior surface of the petrous part of the temporal bone. It transmits the vestibulocochlear nerve and the motor and sensory roots of the facial nerve.

The **internal occipital crest** runs upward in the midline posteriorly from the foramen magnum to the **internal occipital protuberance;** to it is attached the small **falx cerebella** over the **occipital sinus.**

On each side of the internal occipital protuberance is a wide groove for the **transverse sinus**. This groove sweeps around on either side, on the internal surface
of the occipital bone, to reach the posteroinferior angle or corner of the parietal bone. The groove now passes onto the mastoid part of the temporal bone, and here the transverse sinus becomes the **sigmoid sinus.** The **superior petrosal sinus** runs

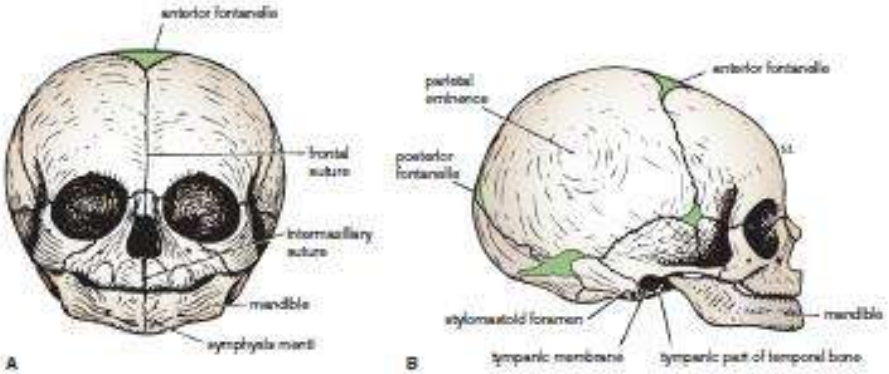
backward along the upper border of the petrous bone in a narrow groove and drains into the sigmoid sinus. As the sigmoid sinus descends to the jugular foramen, it deeply grooves the back of the petrous bone and the mastoid part of the temporal bone. Here, it lies directly posterior to the mastoid antrum.

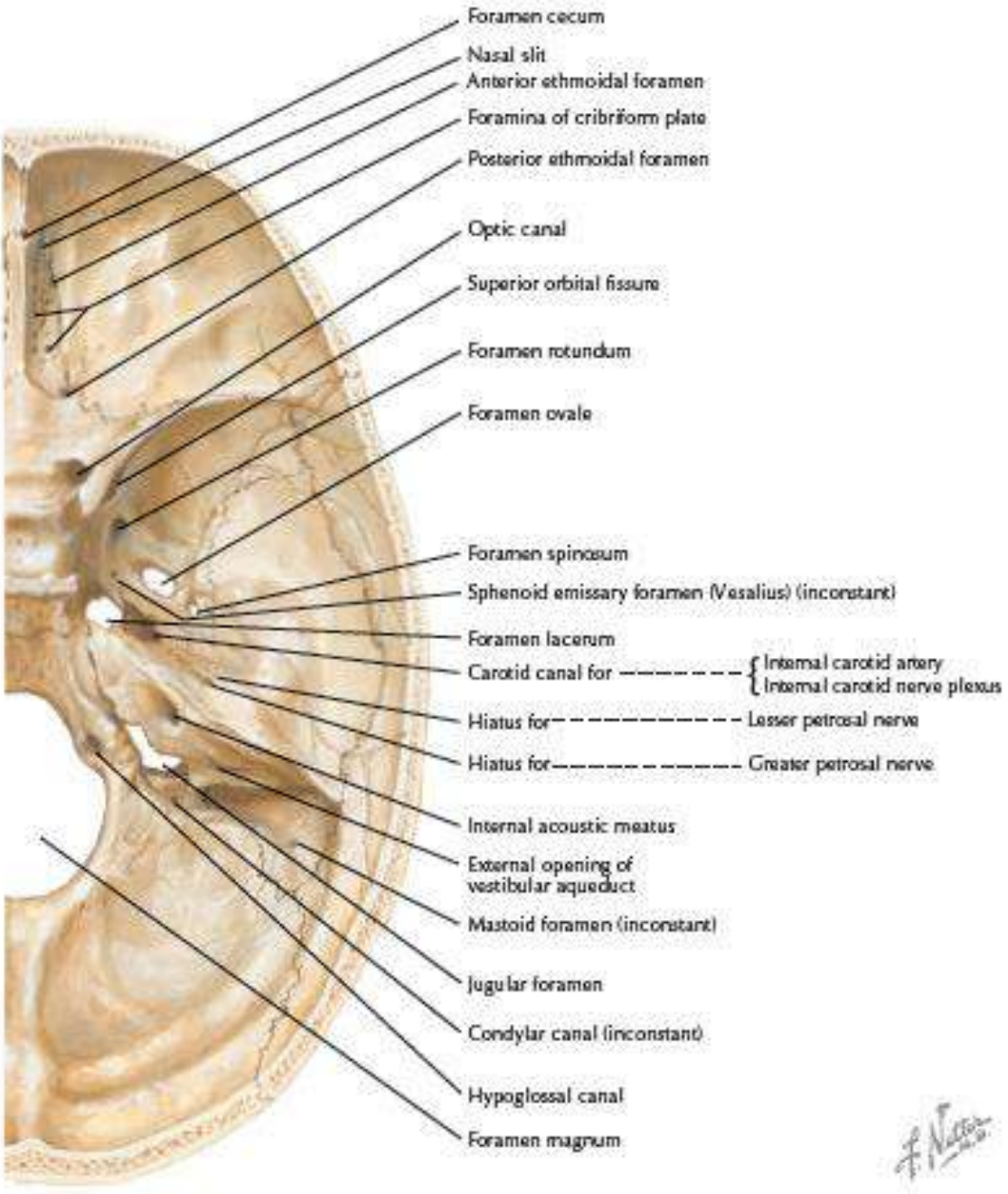


Opening in Skull	Bone of Skull	Structures Transmitted
Anterior Cranial Fossa		
Perforations in cribriform plate	Ethmoid	Olfactory nerves
Middle Cranial Fossa		
Optic canal	Lesser wing of sphenoid	Optic nerve, ophthalmic artery
Superior orbital fissure	Between lesser and greater wings of sphenoid	Lacrimal, frontal, trochlear, oculomotor, nasociliary, and abducent nerves; superior ophthalmic vein
Foramen rotundum	Greater wing of sphenoid	Maxillary division of the trigeminal nerve
Foramen ovale	Greater wing of sphenoid	Mandibular division of the trigeminal nerve, lesser petrosal nerve
Foramen spinosum	Greater wing of sphenoid	Middle meningeal artery
Foramen lacerum	Between petrous part of temporal and sphenoid	Internal carotid artery
Posterior Cranial Fossa		
Foramen magnum	Occipital	Medulla oblongata, spinal part of accessory nerve, and right and left vertebral arteries
Hypoglossal canal	Occipital	Hypoglossal nerve
Jugular foramen	Between petrous part of temporal and condylar part of occipital	Glossopharyngeal, vagus, and accessory nerves; sigmoid sinus becomes internal jugular vein
Internal acoustic m	Petrous part of temporal	Vestibulocochlear and facial nerves

Neonatal Skull

The newborn skull, compared with the adult skull, has a disproportionately large cranium relative to the face. In childhood, the growth of the mandible, the maxillary sinuses, and the alveolar processes of the maxillae results in a great increase in length of the face. The bones of the skull are smooth and unilaminar, there being no diploë present. Most of the skull bones are ossified at birth, but the process is incomplete, and the bones are mobile on each other, being connected by fibrous tissue or cartilage. The bones of the vault are ossified in membrane; the bones of the base are ossified in cartilage. The bones of the vault are not closely knit at sutures, as in the adult, but are separated by unossified membranous intervals called **fontanelles.** Clinically, the anterior and posterior fontanelles are most important and are easily examined in the midline of the vault. The **anterior fontanelle** is diamond shaped and lies between the two halves of the frontal bone in front and the two parietal bones behind. The fibrous membrane forming the floor of the anterior fontanelle is replaced by bone and is closed by 18 months of age. The **posterior fontanelle** is triangular and lies between the two parietal bones in front and the occipital bone behind. By the end of the 1st year, the fontanelle is usually closed and can no longer be palpated. The **tympanic part of the temporal bone** is merely a C-shaped ring at birth, compared with a C-shaped curved plate in the adult. This means that the external auditory meatus is almost entirely cartilaginous in the newborn, and the **tympanic membrane** is nearer the surface. Although the tympanic membrane is nearly as large as in the adult, it faces more inferiorly. During childhood, the tympanic plate grows laterally, forming the bony part of the meatus, and the tympanic membrane comes to face more directly laterally. The **mastoid process** is not present at birth and develops later in response to the pull of the sternocleidomastoid muscle when the child moves his or her head. At birth, the mastoid antrum lies about 3 mm deep to the floor of the **suprameatal triangle.** As growth of the skull continues, the lateral bony wall thickens so that at puberty the antrum may lie as much as 15 mm from the surface. The mandible has right and left halves at birth, united in the midline with fibrous tissue. The two halves fuse at the **symphysis menti** by the end of the 1st year. The **angle of the mandible** at birth is obtuse, the head being placed level with the upper margin of the body and the coronoid process lying at a superior level to the head. It is only after eruption of the permanent teeth that the angle of the mandible assumes the adult shape and the head and neck grow so that the head comes to lie higher than the coronoid process. In old age, the size of the mandible is reduced when the teeth are lost. As the alveolar part of the bone becomes smaller, the ramus becomes oblique in position so that the head is bent posteriorly.


anterior fontanelle
frontal suture
intermaxillary suture
mandible
symphysis menti
A
anterior fontanelle
parietal eminence
posterior fontanelle
mandible
stylomastoid foramen
tympanic membrane
tympanic part of temporal bone
B


Foramen cecum
Nasal slit
Anterior ethmoidal foramen
Foramina of cribriform plate
Posterior ethmoidal foramen
Optic canal
Superior orbital fissure
Foramen rotundum
Foramen ovale
Foramen spinosum
Sphenoid emissary foramen (Vesalius) (inconstant)
Foramen lacerum
Carotid canal for
Internal carotid artery
Internal carotid nerve plexus
Hiatus for
Lesser petrosal nerve
Hiatus for
Greater petrosal nerve
Internal acoustic meatus
External opening of vestibular aqueduct
Mastoid foramen (inconstant)
Jugular foramen
Condylar canal (inconstant)
Hypoglossal canal
Foramen magnum

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1- Snell, Richard S. Clinical anatomy by regions. Lippincott Williams & Wilkins, 2011.

2- Norton, Neil S. Netter's head and neck anatomy for dentistry e-book. Elsevier Health Sciences, 2016.

Lecture 2 Skull second stage

د.احمد جسام النقيب

Basic anatomy

The head and neck region of the body contains many important structures compressed into a relatively small area.

The Head

The head is formed mainly by the skull with the brain and its covering meninges enclosed in the cranial cavity. The special senses, the eye and the ear, lie within the skull bones or in the cavities bounded by them. The brain gives rise to 12 pairs of cranial nerves, which leave the brain and pass through foramina and fissures in the skull. All the cranial nerves are distributed to structures in the head and neck, except the 10th, which also supplies structures in the chest and abdomen.

Bones of the Skull

Composition

The skull is composed of several separate bones united at immobile joints called **sutures**. The connective tissue between the bones is called a **sutural ligament**. The mandible is an exception to this rule, for it is united to the skull by the mobile temporomandibular joint.

The bones of the skull can be divided into those of the cranium and those of the face. The **vault** is the upper part of the cranium, and the **base of the skull** is the lowest part of the cranium.

The skull bones are made up of **external** and **internal tables** of compact bone separated by a layer of spongy bone called the **diploë**. The internal table is thinner and more brittle than the external table. The bones are covered on the outer and inner surfaces with periosteum.

The **cranium** consists of the following bones, two of which are paired :

- Frontal bone: 1
- Parietal bones: 2
- Occipital bone: 1
- Temporal bones: 2
- Sphenoid bone: 1
- Ethmoid bone: 1

The **facial bones** consist of the following, two of which are single:

- Zygomatic bones: 2
- Maxillae: 2

- Nasal bones: 2
- Lacrimal bones: 2
- Vomer: 1
- Palatine bones: 2
- Inferior conchae: 2
- Mandible: 1

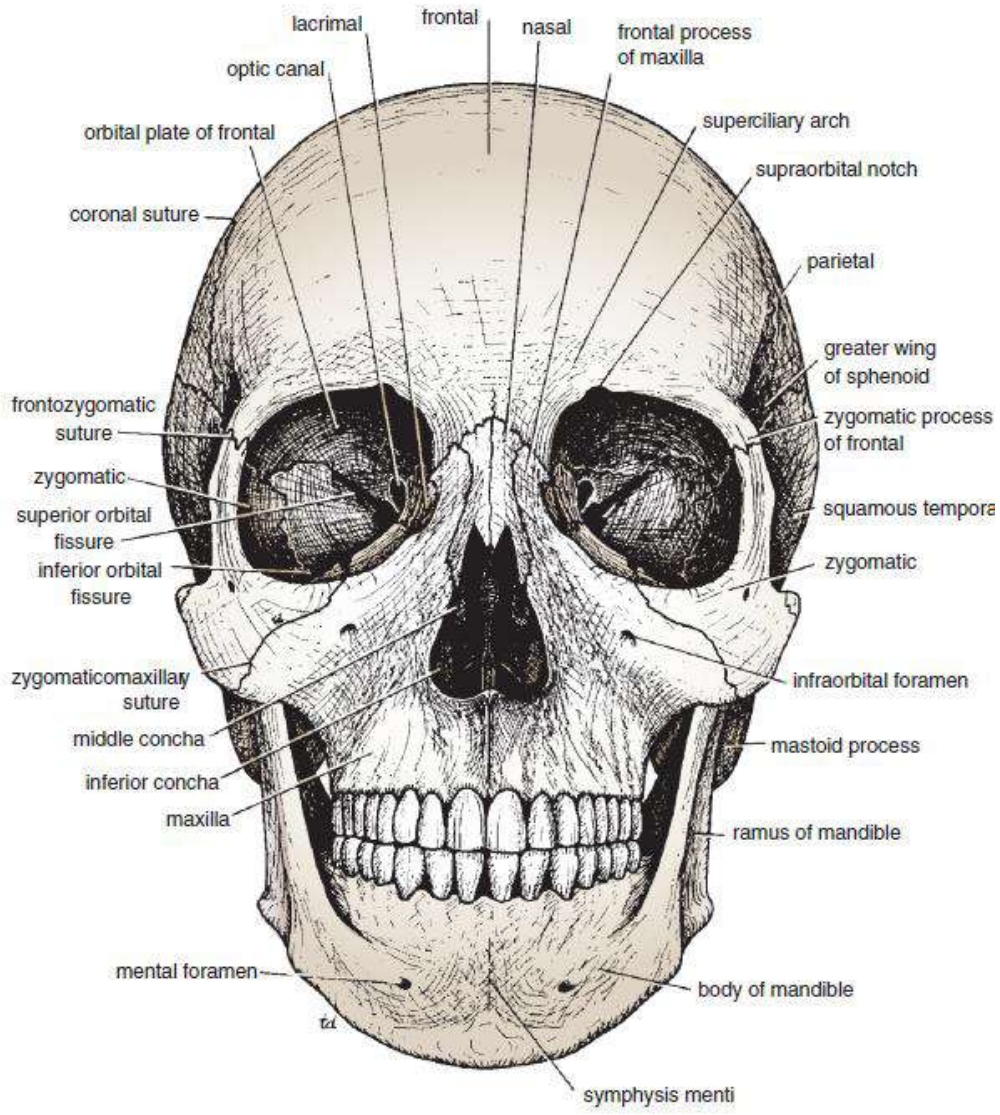
Anterior View of the Skull

The **frontal bone**, or forehead bone, curves downward to make the upper margins of the orbits
The **superciliary arches** can be seen on either side, and the **supraorbital notch**, or **foramen**, can be recognized. Medially, the frontal bone articulates with the frontal processes of the maxillae and with the nasal bones. Laterally, the frontal bone articulates with the zygomatic bone.
The **orbital margins** are bounded by the frontal bone superiorly, the zygomatic bone laterally, the maxilla inferiorly, and the processes of the maxilla and frontal bone medially.
Within the **frontal bone**, just above the orbital margins, are two hollow spaces lined with mucous membrane called the **frontal air sinuses**. These communicate with the nose and serve as voice resonators. The two **nasal bones** form the bridge of the nose. Their lower borders, with the maxillae, make the **anterior nasal aperture**. The nasal cavity is divided into two by the bony nasal septum, which is largely formed by the **vomer.** The **superior** and **middle conchae** are shelves of bone that project into the nasal cavity from the **ethmoid** on each side; the **inferior conchae** are separate bones.

The two **maxillae** form the upper jaw, the anterior part of the hard palate, part of the lateral walls of the nasal cavities, and part of the floors of the orbital cavities. The two bones meet in the midline at the **intermaxillary suture** and form the lower margin of the nasal aperture. Below the orbit, the maxilla is perforated by the **infraorbital foramen**. The **alveolar process** projects downward and, together with the fellow of the opposite side, forms the **alveolar arch**, which carries the upper teeth. Within each maxilla is a large, pyramid- shaped cavity lined with mucous membrane called the **maxillary sinus**. This communicates with the nasal cavity and serves as a voice resonator.

The **zygomatic bone** forms the prominence of the cheek and part of the lateral wall and floor of the orbital cavity. Medially, it articulates with the maxilla and laterally it articulates with the zygomatic process of the temporal bone to form the zygomatic arch. The zygomatic bone is perforated by two foramina for the zygomaticofacial and zygomaticotemporal nerves.

The **mandible**, or lower jaw, consists of a horizontal body and two vertical rami.



Lateral View of the Skull

The **frontal bone** forms the anterior part of the side of the skull and articulates with the parietal bone at the coronal suture. The **parietal bones** form the sides and roof of the cranium and articulate with each other in the midline at the **sagittal suture**. They articulate with the occipital bone behind, at the **lambdoid suture**. The skull is completed at the side by the squamous part of the **occipital bone**; parts of the **temporal bone**, namely, the **squamous**, **tympanic**, **mastoid process**, **styloid process**, and **zygomatic process**; and the **greater wing of the sphenoid**.

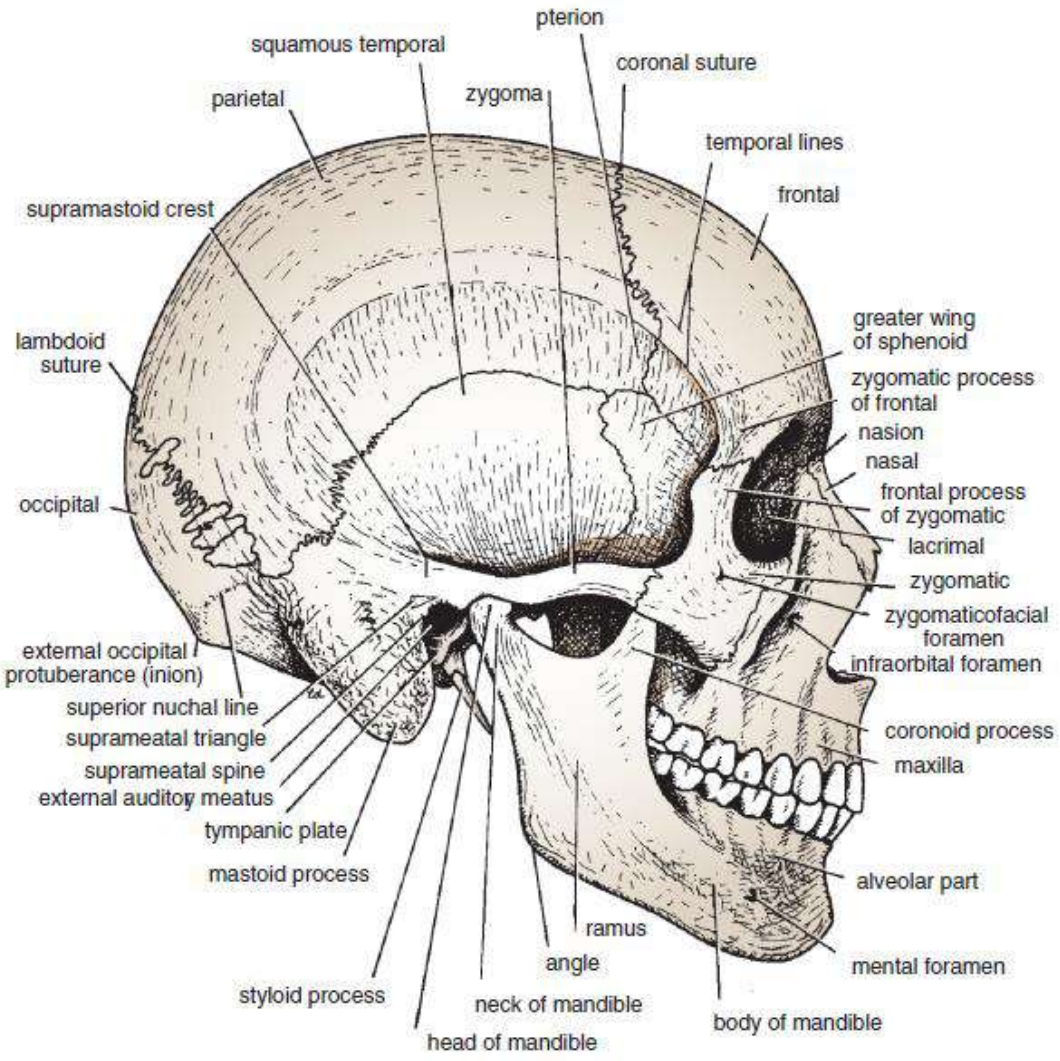
Note the position of the external auditory meatus. The ramus and body of the mandible lie inferiorly. Note that the thinnest part of the lateral wall of the skull is where the anteroinferior corner of the parietal bone articulates with the greater wing of the sphenoid; this point is referred to as the **pterion**. Clinically, the pterion is an important area because it overlies the anterior division of the **middle meningeal artery** and **vein**. Identify the **superior** and **inferior temporal lines**, which begin as a

single line from the posterior margin of the zygomatic process of the frontal bone and diverge as they arch backward. The **temporal fossa** lies below the inferior temporal line.

The **infratemporal fossa** lies below the **infratemporal crest** on the greater wing of the sphenoid. The **pterygomaxillary fissure** is a vertical fissure that lies within the fossa between the pterygoid process of the sphenoid bone and back of the maxilla. It leads medially into the **pterygopalatine fossa**.

The **inferior orbital fissure** is a horizontal fissure between the greater wing of the sphenoid bone and the maxilla. It leads forward into the orbit.

The **pterygopalatine fossa** is a small space behind and below the orbital cavity. It communicates laterally with the infratemporal fossa through the pterygomaxillary fissure, medially with the nasal cavity through the **sphenopalatine foramen**, superiorly with the skull through the **foramen rotundum**, and anteriorly with the orbit through the **inferior orbital fissure**.

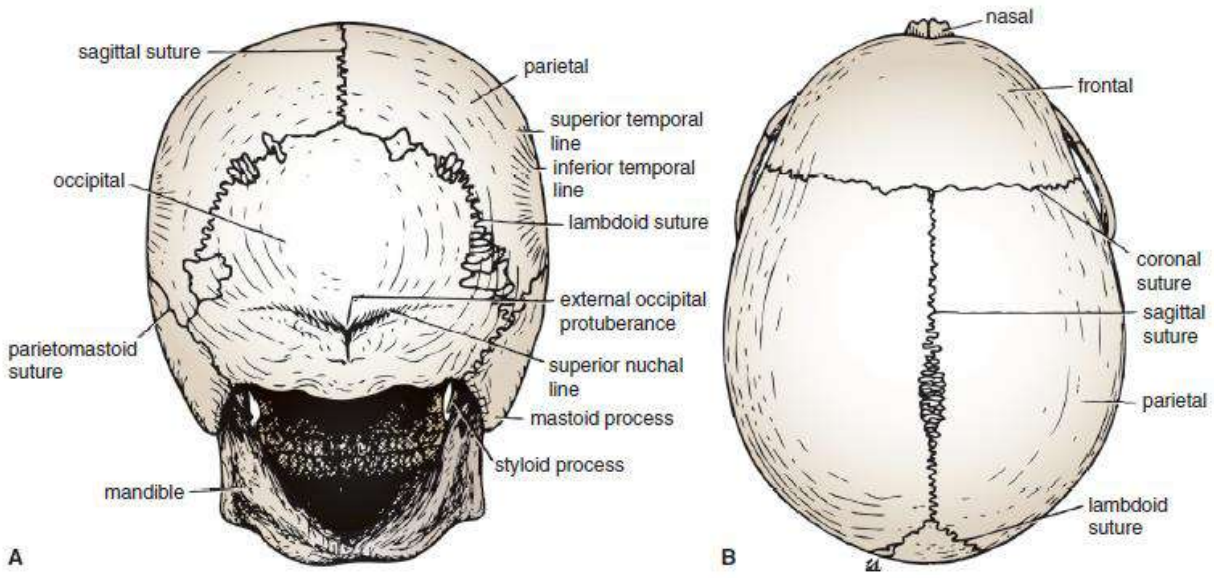


Posterior View of the Skull

The posterior parts of the two parietal bones with the intervening **sagittal suture** are seen above. Below, the parietal bones articulate with the squamous part of the occipital bone at the **lambdoid suture**. On each side the occipital bone articulates with the temporal bone. In the midline of the occipital bone is a roughened elevation called the **external occipital protuberance**, which gives attachment to muscles and the ligamentum nuchae. On either side of the protuberance the **superior nuchal lines** extend laterally toward the temporal bone.

Superior View of the Skull

Anteriorly, the frontal bone articulates with the two parietal bones at the **coronal suture**. Occasionally, the two halves of the frontal bone fail to fuse, leaving a midline **metopic suture**. Behind, the two parietal bones articulate in the midline at the **sagittal suture**.



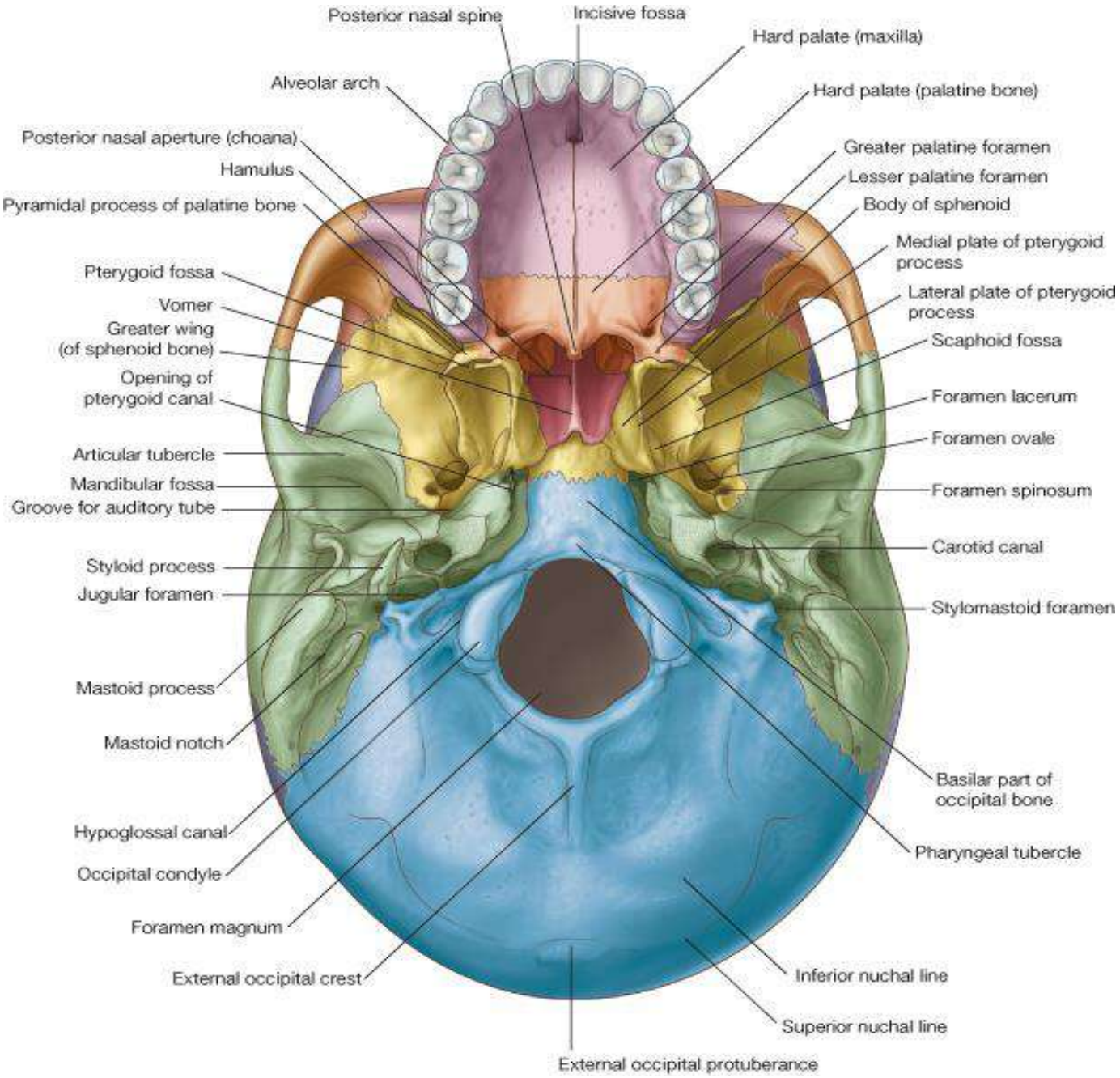
Inferior View of the Skull

If the mandible is discarded, the anterior part of this aspect of the skull is seen to be formed by the **hard palate**. The **palatal processes of the maxillae** and the **horizontal plates of the palatine bones** can be identified. In the midline anteriorly is the **incisive fossa** and **foramen**. Posterolaterally are the **greater** and **lesser palatine foramina**.

Above the posterior edge of the hard palate are the **choanae** (posterior nasal apertures). These are separated from each other by the posterior margin of the **vomer** and are bounded laterally by the **medial pterygoid plates** of the sphenoid bone. The inferior end of the medial pterygoid plate is prolonged as a curved spike of bone, the **pterygoid hamulus.**

Posterolateral to the **lateral pterygoid plate**, the greater wing of the sphenoid is pierced by the large **foramen ovale** and the small **foramen spinosum**. Posterolateral to the foramen spinosum is the **spine of the sphenoid**.
Behind the spine of the sphenoid, in the interval between the greater wing of the sphenoid and the petrous part of the temporal bone, is a groove for the cartilaginous part of the **auditory tube**. The opening of the bony part of the tube can be identified.

The **mandibular fossa** of the temporal bone and the **articular tubercle** form the upper articular surfaces for the temporomandibular joint. Separating the mandibular fossa from the tympanic plate posteriorly is the **squamotympanic fissure**, through the medial end of which the chorda tympani nerve exits from the tympanic cavity. The **styloid process** of the temporal bone projects downward and forward from its inferior aspect. The opening of the **carotid canal** can be seen on the inferior surface of the petrous part of the temporal bone. The medial end of the petrous part of the temporal bone is irregular and, together with the basilar part of the occipital bone and the greater wing of the sphenoid, forms the **foramen lacerum**. During life, the foramen lacerum is closed with fibrous tissue, and only a few small vessels pass through this foramen from the cavity of the skull to the exterior. The **tympanic plate**, which forms part of the temporal bone, is C shaped on section and forms the bony part of the **external auditory meatus**. While examining this region, identify the **suprameatal crest** on the lateral surface of the squamous part of the temporal bone, the **suprameatal triangle**, and the **suprameatal spine**. In the interval between the styloid and mastoid processes, the **stylomastoid foramen** can be seen.
Medial to the styloid process, the petrous part of the temporal bone has a deep notch, which, together with a shallower notch on the occipital bone, forms the **jugular foramen**.
Behind the posterior apertures of the nose and in front of the foramen magnum are the sphenoid bone and the basilar part of the occipital bone. The **pharyngeal tubercle** is a small prominence on the undersurface of the basilar part of the occipital bone in the midline. The **occipital condyles** should be identified; they articulate with the superior aspect of the lateral mass of the first cervical vertebra, the atlas. Superior to the occipital condyle is the **hypoglossal canal** for transmission of the hypoglossal nerve.
Posterior to the foramen magnum in the midline is the external occipital protuberance. The superior nuchal lines should be identified as they curve laterally on each side.



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2- Norton, Neil S. Netter's head and neck anatomy for dentistry e-book. Elsevier Health Sciences, 2016.

Lecture 1 Human Anatomy second stage

د.احمد جسام

Anatomy is the science of the structure and function of the body.

Clinical anatomy is the study of the macroscopic structure and function of the body as it relates to the practice of medicine and other health sciences.

Basic anatomy is the study of the minimal amount of anatomy consistent with the understanding of the overall structure and function of the body.

Descriptive Anatomic Terms:

It is important for medical personnel to have a sound knowledge and understanding of the basic anatomic terms. With the aid of a medical dictionary, you will find that understanding anatomic terminology greatly assists you in the learning process.
The accurate use of anatomic terms by medical personnel enables them to communicate with their colleagues both nationally and internationally. Without anatomic terms, one cannot accurately discuss or record the abnormal functions of joints, the actions of muscles, the alteration of position of organs, or the exact location of swellings or tumors.

Terms Related to Position:

All descriptions of the human body are based on the assumption that the person is standing erect, with the upper limbs by the sides and the face and palms of the hands directed forward. This is the so-called anatomic position. The various parts of the body are then described in relation to certain imaginary planes.

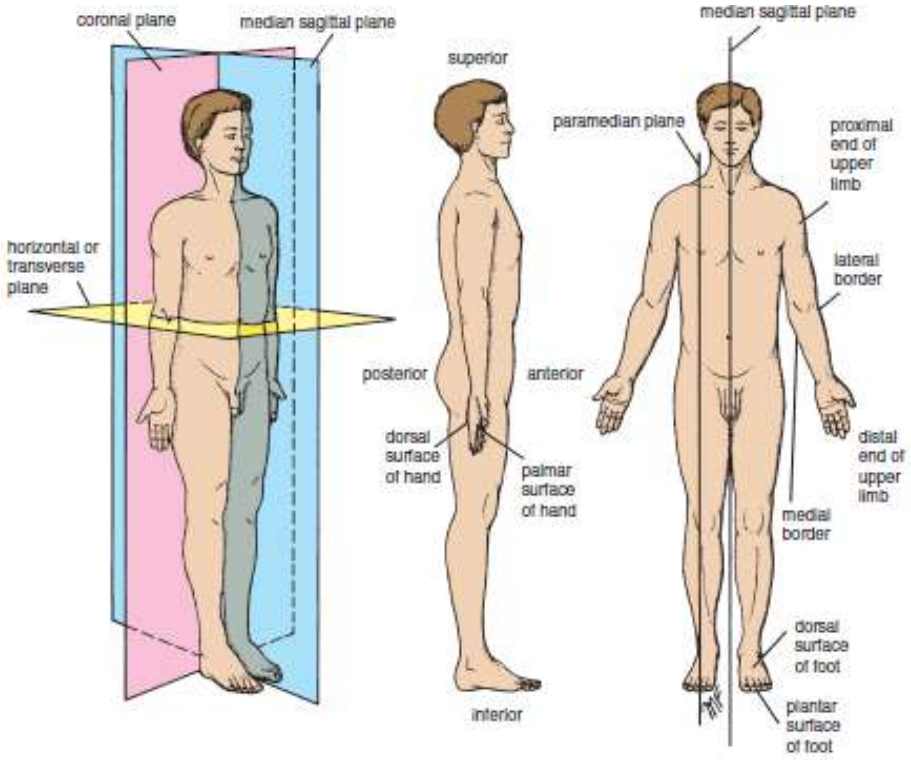
Median Sagittal Plane

This is a vertical plane passing through the center of the body, dividing it into equal right and left halves. Planes situated to one or the other side of the median plane and parallel to it are termed paramedian.

A structure situated nearer to the median plane of the body than another is said to be medial to the other. Similarly, a structure that lies farther away from the median plane than another is said to be lateral to the other.

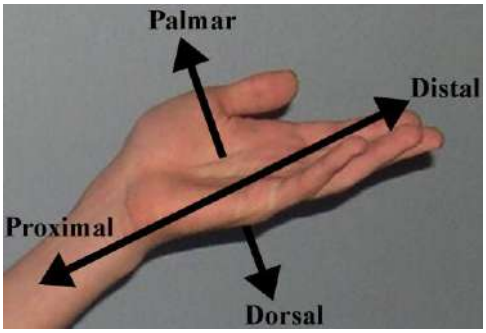
Coronal Planes
These planes are imaginary vertical planes at right angles to the median plane.

Horizontal, or Transverse Planes
These planes are at right angles to both the median and the coronal planes.
The terms anterior and posterior are used to indicate the front and back of the body, respectively.



To describe the relationship of two structures, one is said to be anterior or posterior to the other insofar as it is closer to the anterior or posterior body surface.

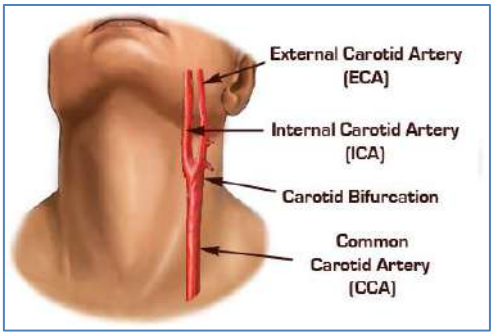
In describing the hand, the terms palmar and dorsal surfaces are used in place of anterior and posterior, and in describing the foot, the terms plantar and dorsal surfaces are used instead of lower and upper surfaces



The terms proximal and distal describe the relative distances from the roots of the limbs; for example, the arm is proximal to the forearm and the hand is distal to theforearm.

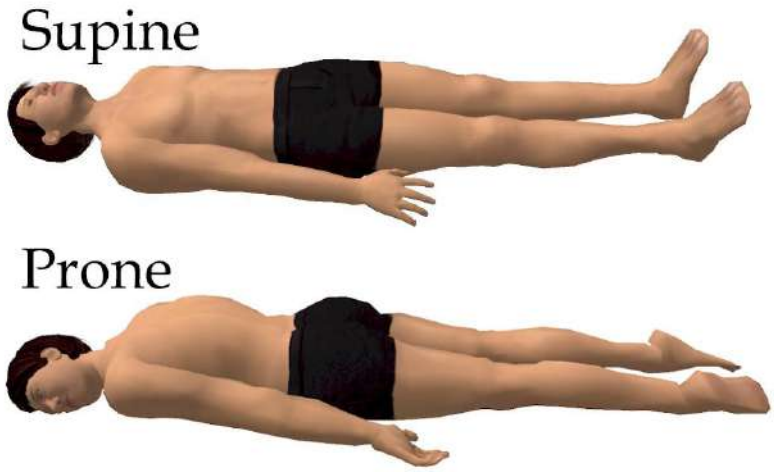
The terms superficial and deep denote the relative distances of structures from the surface of the body, and the terms superior and inferior denote levels relatively high or low with reference to the upper and lower ends of the body.

The terms internal and external are used to describe the relative distance of a structure from the center of an organ or cavity; for example, the internal carotid artery is found inside the cranial cavity and the external carotid artery is found outside the cranial cavity.



The term ipsilateral refers to the same side of the body; for example, the left hand and the left foot are ipsilateral. Contralateral refers to opposite sides of the body; for example, the left eye and the right ear are contralateral.

The supine position of the body is lying on the back. The prone position is lying face downward.



Terms Related to Movement

A site where two or more bones come together is known as a **joint**. Some joints have no movement (sutures of the skull), some have only slight movement (superior tibiofibular joint), and some are freely movable (shoulder joint).

Flexion is a movement that takes place in a sagittal plane. For example, flexion of the elbow joint approximates the anterior surface of the forearm to the anterior surface of the arm. It is usually an anterior movement, but it is occasionally posterior, as in the case of the knee joint.

Extension means straightening the joint and usually takes place in a posterior direction.
Lateral flexion is a movement of the trunk in the coronal plane.

Abduction is a movement of a limb away from the midline of the body in the coronal plane.
Adduction is a movement of a limb toward the body in the coronal plane .

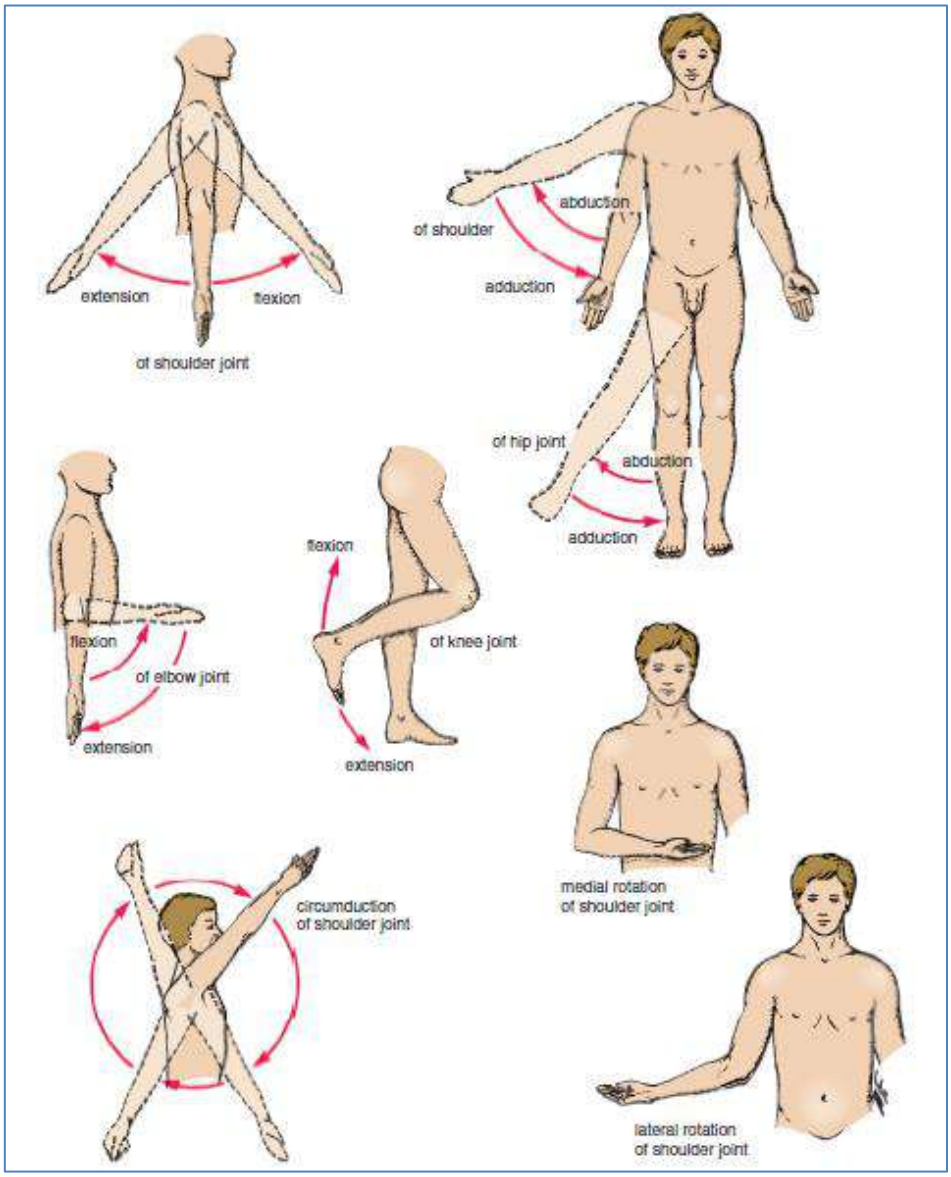
Rotation is the term applied to the movement of a part of the body around its long axis. **Medial rotation** is the movement that results in the anterior surface of the part facing medially. **Lateral rotation** is the movement that results in the anterior surface of the part facing laterally.

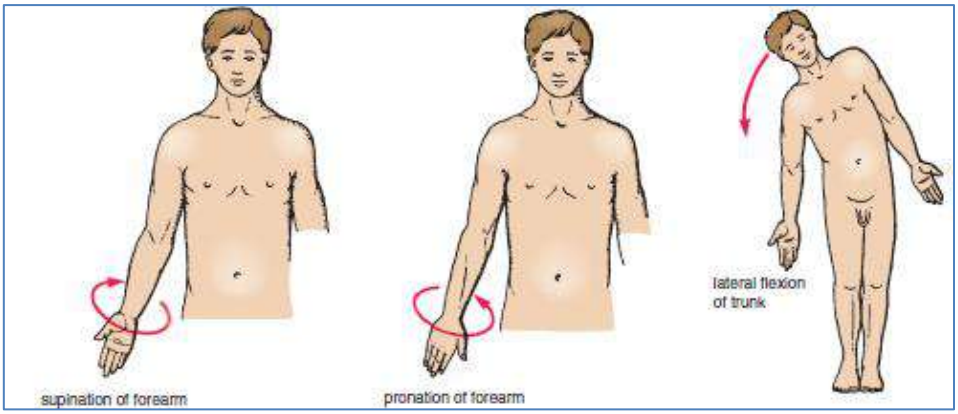
Pronation of the forearm is a medial rotation of the forearm in such a manner that the palm of the hand faces posteriorly. **Supination** of the forearm is a lateral rotation of the forearm from the pronated position so that the palm of the hand comes to face anteriorly.

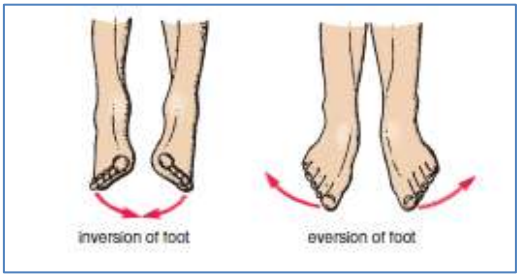
Circumduction is the combination in sequence of the movements of flexion, extension, abduction, and adduction.

Protraction is to move forward; **Retraction** is to move backward (used to describe the forward and backward movement of the jaw at the temporomandibular joints).

Inversion is the movement of the foot so that the sole faces in a medial direction . **Eversion** is the opposite movement of the foot so that the sole faces in a lateral direction.







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