كلية المستقبل الجامعة قسم هندسة الطب الحياتي

المرحلة الثانية

HEAD & NECK

ANATOMY

(L9)

Head and Neck Nerves

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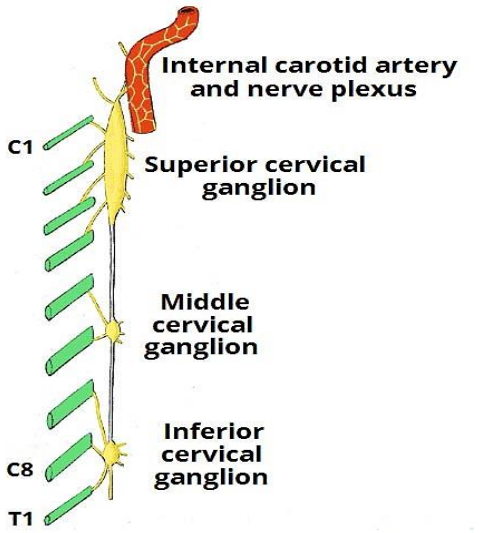
Sympathetic Innervation to the Head and Neck

The **sympathetic nervous** system is a division of the autonomic nervous system. It is involuntary, and acts with the parasympathetic system to maintain body homeostasis. The actions of the sympathetic nervous system are associated with the 'fight or flight' response.

Anatomical Structure and Course

The sympathetic fibres to the head and neck begin in the spinal cord. They originate from the thoracic region (T1-6), and therefore need to ascend to reach the structures in the head and neck.

After leaving the spinal cord, the fibres enter the **sympathetic chain**. This structure spans from the base of the skull to the coccyx, and is formed by nerve fibres and ganglia (collections of nerve cell bodies). There are three ganglia within this chain that are of interest the **superior, middle and inferior cervical ganglia**. The sympathetic fibres synapse with these ganglia, with post ganglionic branches continuing into the head and neck.



Each of the three ganglia are related to specific arteries in the head and neck. The post-ganglionic fibres **hitch-hike** along these arteries (and their branches) in order to reach their target organs.

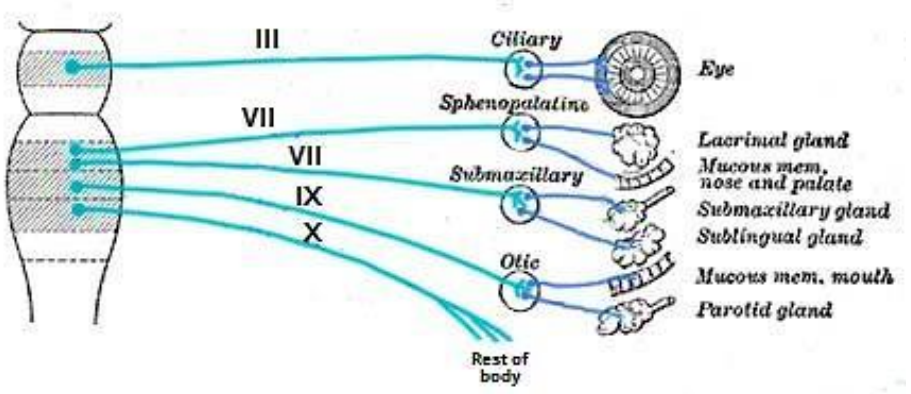
Parasympathetic Innervation to the Head and Neck

The actions of the parasympathetic nervous system are associated with the 'rest and digest' response.

Overview of Parasympathetic Supply

The parasympathetic fibres begin in the central nervous system. The nerves supplying the head and neck are situated within four **nuclei**, located within the brainstem. Each nucleus is associated with a **cranial nerve** (the oculomotor, facial, glossopharyngeal and vagus nerves) – these nerves carry the parasympathetic fibres out of the brain.

After leaving the brain, the parasympathetic fibres from each nuclei synapse in a **peripheral ganglion** (a collection of neurone cell bodies outside the CNS). These ganglia are typically located near to the target viscera. From the ganglia, post-ganglionic parasympathetic fibres continue to the organs in the head and neck, providing parasympathetic innervation.There are four parasympathetic ganglia located within the head – the ciliary, otic, pterygopalatine and submandibular. They receive fibres from the oculomotor, facial and glossopharyngeal nerves (the vagus nerve only innervates structures in the thorax and abdomen).



Trigeminal Nerve

The trigeminal nerve originates from **four nuclei**, which extend from the midbrain to the medulla (a nucleus refers to a collection of nerve cell bodies within the central nervous system):

- Three sensory nuclei:
    - Mesencephalic nucleus
    - Principle sensory nucleus
    - Spinal nucleus
- Motor nucleus of the trigeminal nerve

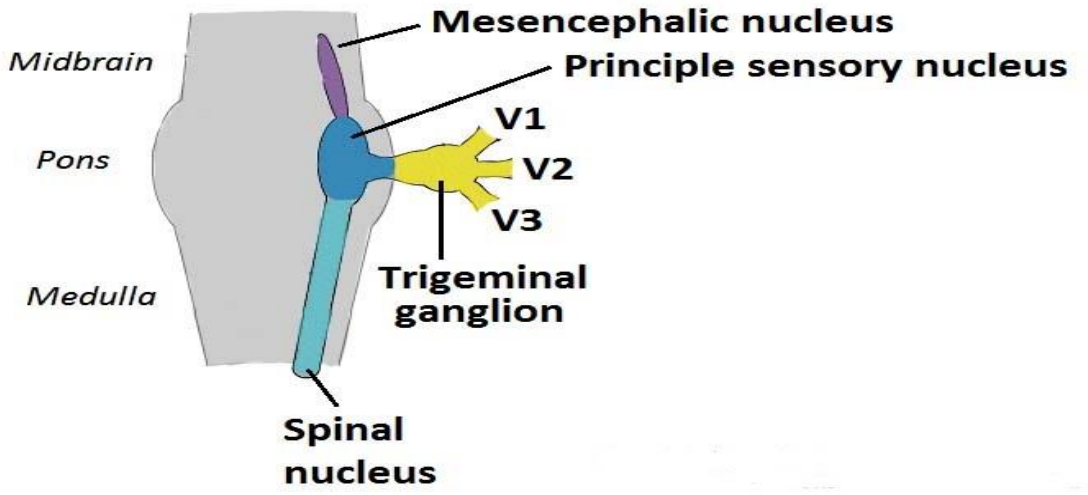
At the level of the **pons**, the sensory nuclei merge to form a sensory root. The motor nucleus continues to form a separate motor root. These roots are analogous with the dorsal and ventral roots of the spinal cord.

Within the middle cranial fossa, the sensory root expands into the **trigeminal ganglion** (a ganglion refers to a collection of the nerve cell bodies outside the central nervous system).

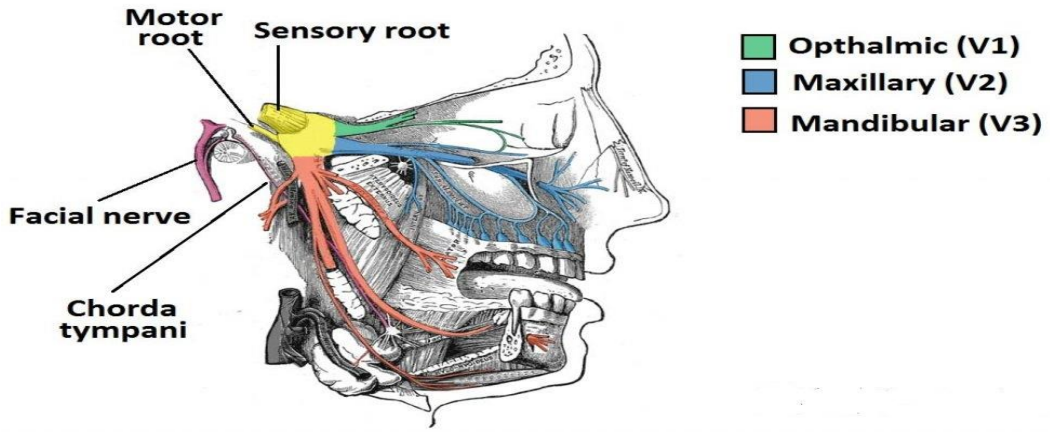
The trigeminal ganglion is located lateral to the cavernous sinus, in a depression of the temporal bone known as the **trigeminal cave** or Meckel's cave.

The motor root passes inferiorly to the sensory root, along the floor of the trigeminal cave. Motor fibres are only distributed to the **mandibular division** (V3).

From the trigeminal ganglion, the **three terminal divisions** of the trigeminal nerve arise; the ophthalmic (V1), maxillary (V2) and mandibular (V3) nerves.



The origin of the trigeminal nerve. Note that the nuclei are situated within in the CNS, and the gangia outside the CNS



Overview of the distribution of the trigeminal nerve and its terminal branches

The **ophthalmic nerve** (CNV1) is a terminal branch of the trigeminal nerve (along with the maxillary and mandibular nerves).

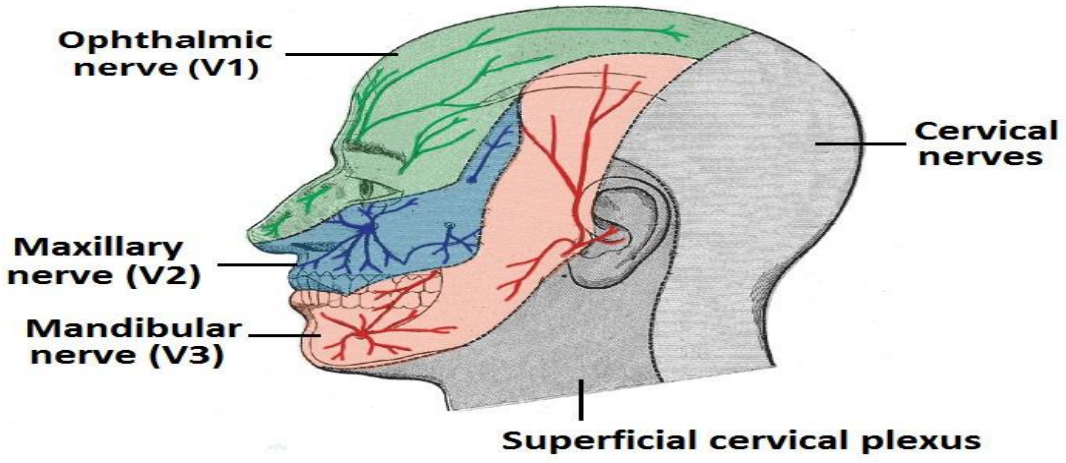
It provides **sensory innervation** to the skin, mucous membranes and sinuses of the upper face and scalp.

The **maxillary nerve** is the second branch of the trigeminal nerve, its primary function is **sensory supply** to the mid-third of the face.

The **mandibular nerve** has a sensory role in the head, and is associated with parasympathetic fibres of other cranial nerves. However unlike the other branches of the trigeminal nerve, the mandibular nerve also has a **motor function**, its axons to the **muscles of mastication**: masseter, medial and lateral pterygoids, temporalis.

Mapping Cutaneous Innervation

The cutaneous innervation to the face and scalp by the three branches of the trigeminal nerve have sharp borders and little overlap.



Cutaneous innervation to the head and neck

The Cervical Plexus

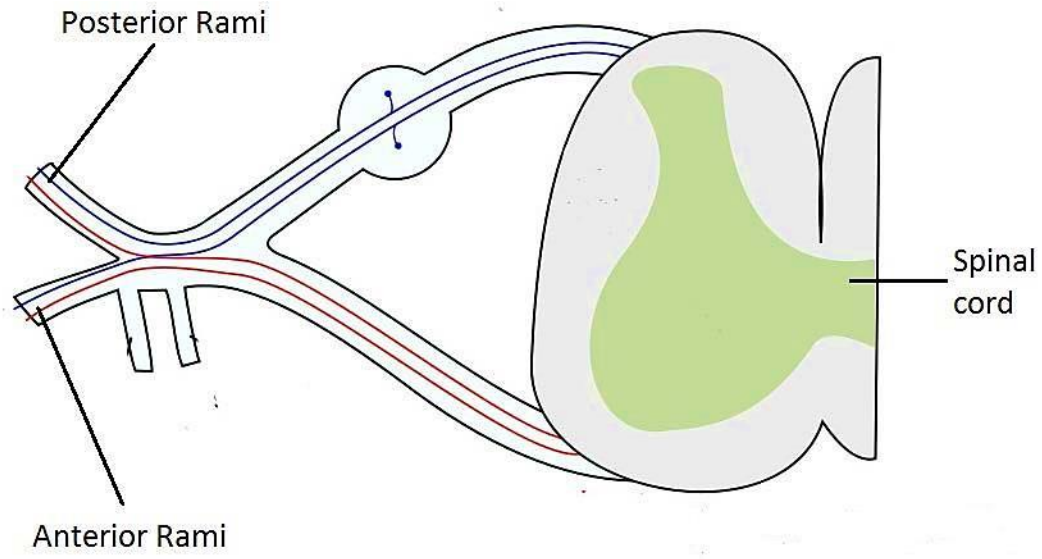
The cervical plexus is a **network** of nerve fibres that supplies innervation to some of the structures in the neck and trunk. It is located in the posterior triangle of the neck, halfway up the sternocleidomastoid

muscle, and within the **prevertebral layer** of cervical fascia. The plexus is formed by the anterior rami (divisions) of cervical spinal nerves C1-C4.

Spinal Nerves

The spinal nerves C1 – C4 form the basis of the cervical plexus.At each vertebral level, paired spinal nerves leave the spinal cord via the **intervertebral foramina** of the vertebral column.

Each nerve then divides into anterior and posterior nerve fibres. The cervical plexus begins as the **anterior fibres** of the spinal nerves C1, C2, C3 and C4.These fibres combine with each other to form the branches of the cervical plexus.



The cervical plexus gives rise to numerous branches which supply structures in the head and neck. They can broadly be divided into two groups – muscular branches and sensory branches.

Muscular Branches

The muscular branches of the cervical plexus are located deep to the sensory branches. They supply some of the muscles of the neck, back and the diaphragm.

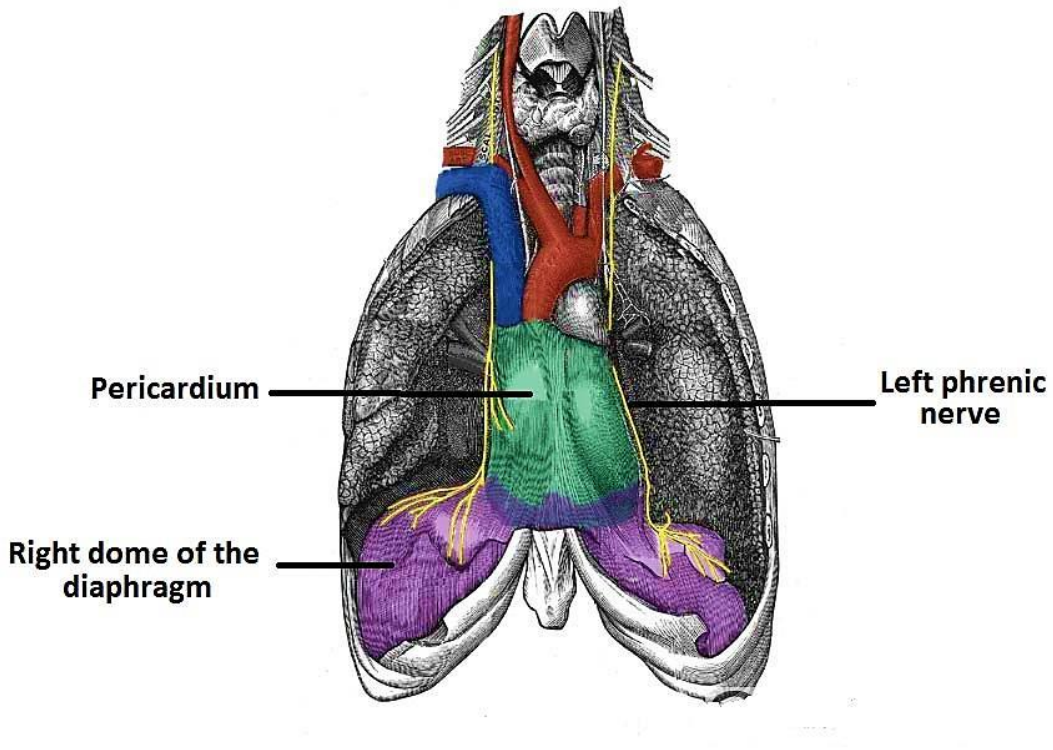
The phrenic nerve

is a bilateral, mixed nerve that originates from the cervical nerves in the neck and descends through the thorax to innervate the diaphragm. It is

the only source of motor innervation to the **diaphragm** and therefore plays a crucial role in breathing.

Overview

- **Nerve roots** – anterior rami of C3, C4 and C5.
- **Motor functions** – innervates the diaphragm.
- **Sensory functions** – innervates the central part of the diaphragm, the pericardium and the mediastinal part of the parietal pleura.



The anatomical course of the phrenic nerves, which innervate the diaphragm.

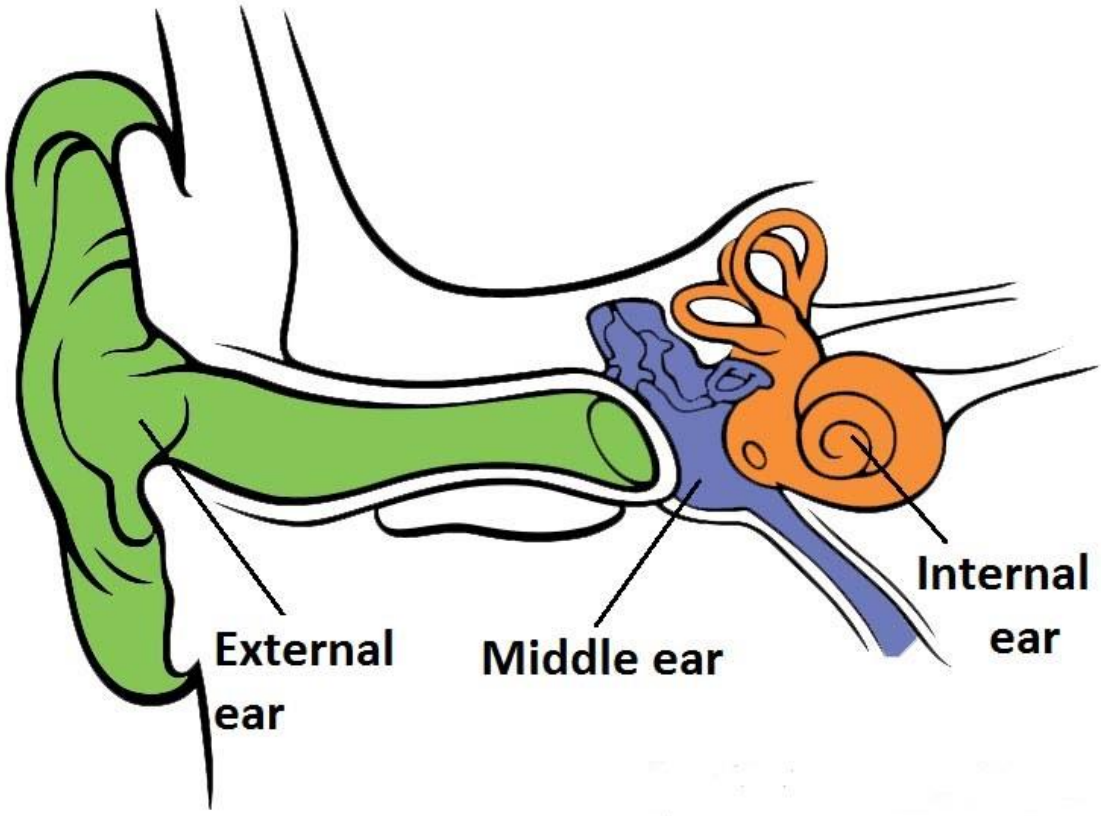
Sensory Branches

The cutaneous branches of the cervical plexus supply the skin of the neck, upper thorax, scalp and ear.

The Ear

The ear can be divided into three parts; external, middle and inner..

The external ear can be divided functionally and structurally into **two parts**; the auricle (or pinna), and the external acoustic meatus – which ends at the tympanic membrane.

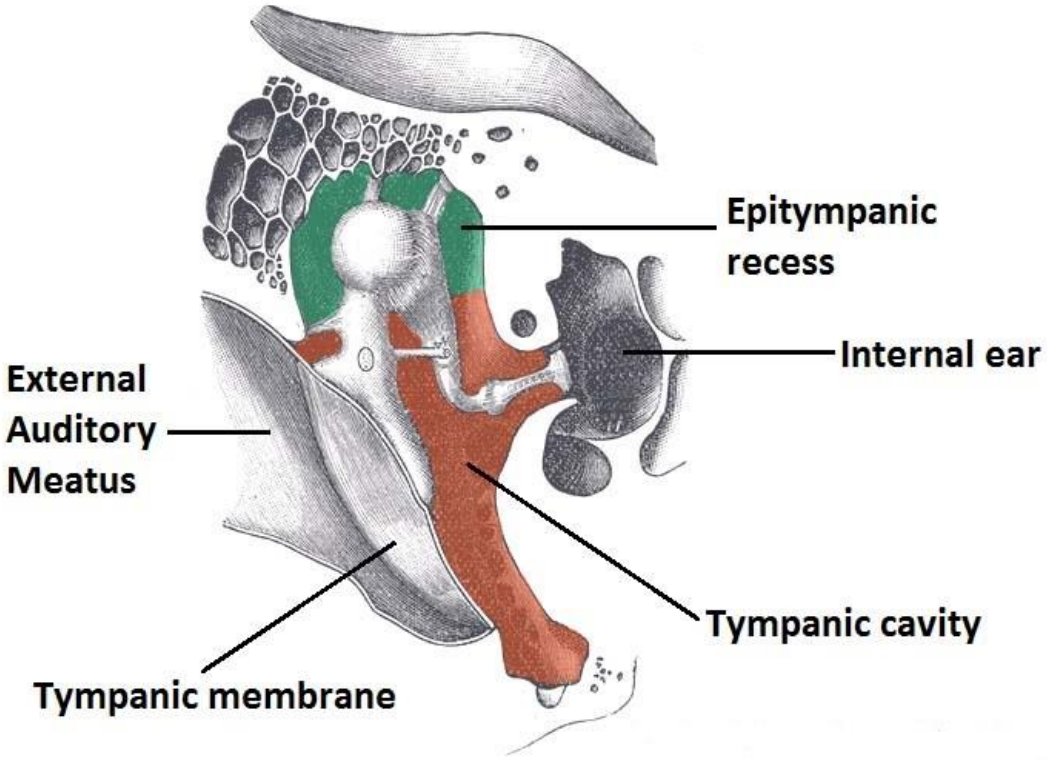


The **middle ear** lies within the temporal bone, and extends from the tympanic membrane to the lateral wall of the inner ear. The main function of the middle ear is to transmit vibrations from the tympanic membrane to the inner ear via the auditory ossicles.

The middle ear can be divided into two parts:

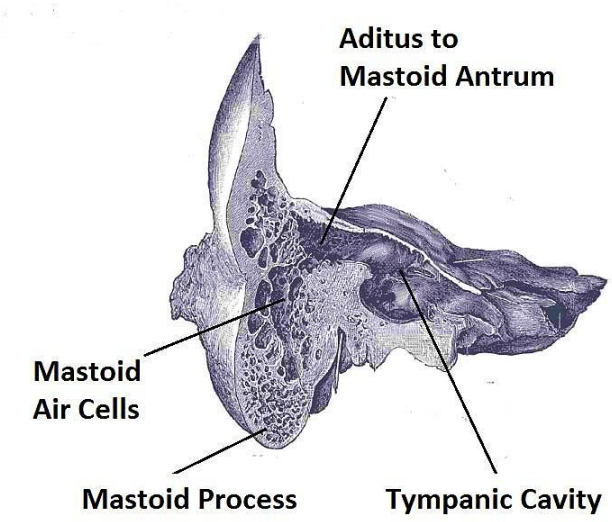
Tympanic cavity – located medially to the tympanic membrane. It contains three small bones known as the auditory ossicles: the malleus, incus and stapes. They transmit sound vibrations through the middle ear.

Epitympanic recess – a space superior to the tympanic cavity, which lies next to the mastoid air cells. The malleus and incus partially extend upwards into the epitympanic recess.



The **mastoid air cells** are located posterior to epitympanic recess. They are a collection of air-filled spaces in the mastoid process of the temporal bone. The air cells are contained within a cavity called the mastoid antrum. The mastoid antrum communicates with the middle ear via the aditus to mastoid antrum.

The mastoid air cells act as a '**buffer system**' of air – releasing air into the tympanic cavity when the pressure is too low



The auditory tube (eustachian tube) isa **cartilaginous** and **bony** tube that connects the middle ear to the **nasopharynx**. It acts

to **equalise** the pressure of the middle ear to that of the external auditory meatus. It is a pathway by which an upper respiratory infection can spread into the middle ear.The tube is shorter and straighter in children, therefore middle ear infections tend to be more common in children than adults.

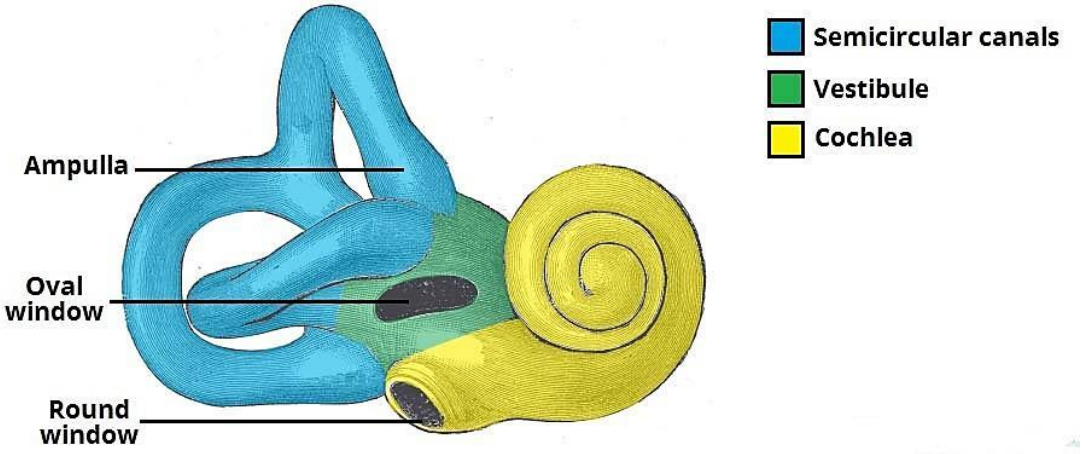
The inner ear is the innermost part of the ear, and houses the vestibulocochlear organs. It has two main functions:

To convert **mechanical** signals from the middle ear into **electrical** signals, which can transfer information to the auditory pathway in the brain.

To maintain balance by **detecting position** and **motion**.

The inner ear is located within the **petrous** part of the **temporal bone**. It lies between the middle ear and the internal acoustic meatus, which lie laterally and medially respectively. The inner ear has two main components – the bony labyrinth and membranous labyrinth.

The inner ear has two openings into the middle ear, both covered by membranes. The **oval window** lies between the middle ear and the vestibule, whilst the **round window** separates the middle ear from the scala tympani (part of the cochlear duct).



The Eye

The **eyeball** is a bilateral and spherical organ, which houses the structures responsible for vision. It lies in a bony cavity within the facial skeleton – known as the bony orbit.

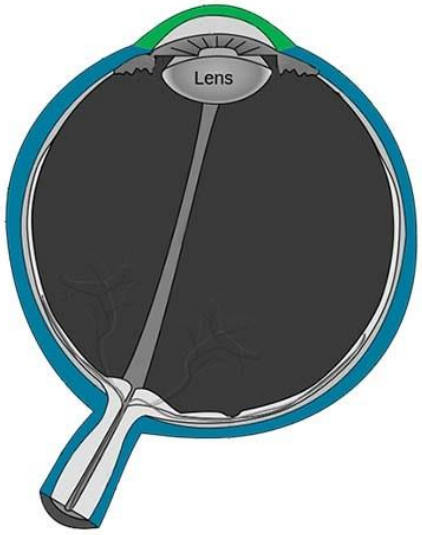
Anatomically, the eyeball can be divided into three parts – the **fibrous**, **vascular** and **inner** layers.

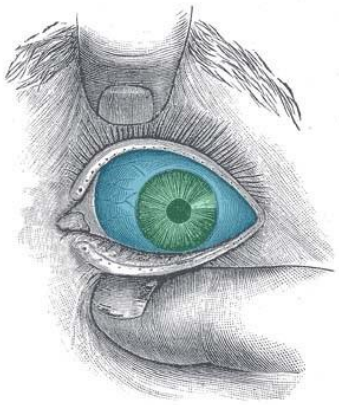
Fibrous

The fibrous layer of the eye is the outermost layer. It consists of the **sclera** and **cornea**, which are continuous with each other. Their main functions are to provide shape to the eye and support the deeper structures.

The **sclera** comprises the majority of the fibrous layer (approximately 85%). It provides attachment to the extraocular muscles – these muscles are responsible for the movement of the eye. It is visible as the white part of the eye.

The **cornea** is transparent and positioned centrally at the front of the eye. Light entering the eye is refracted by the cornea.





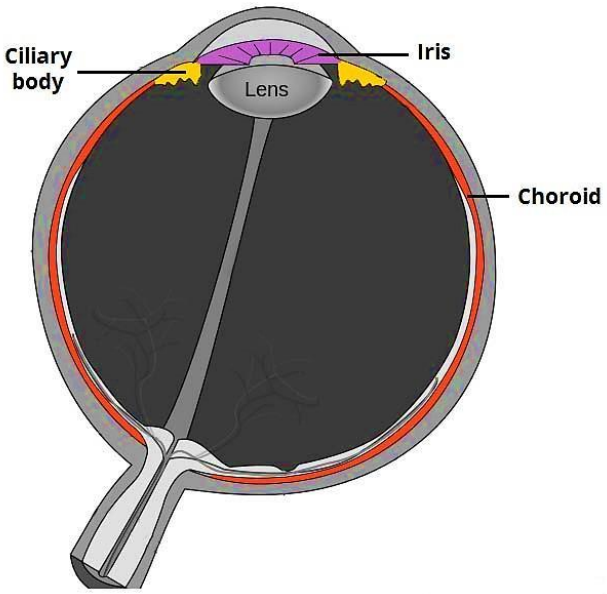
Vascular

The vascular layer of the eye lies underneath the fibrous layer. It consists of the choroid, ciliary body and iris:

Choroid – layer of connective tissue and blood vessels. It provides nourishment to the outer layers of the retina.

Ciliary body – comprised of two parts – the ciliary muscle and ciliary processes. The ciliary muscle consists of a collection of smooth muscles fibres. These are attached to the lens of the eye by the ciliary processes. The ciliary body controls the shape of the lens, and contributes to the formation of aqueous humor

Iris – circular structure, with an aperture in the centre (the pupil). The diameter of the pupil is altered by smooth muscle fibres within the iris, which are innervated by the autonomic nervous system. It is situated between the lens and the cornea.



Inner

The inner layer of the eye is formed by the **retina**; its light detecting component. The retina is composed of two layers:

Pigmented (outer) layer – formed by a single layer of cells. It is attached to the choroid and supports the choroid in absorbing light (preventing scattering of light within the eyeball). It continues around the whole inner surface of the eye.

Neural (inner) layer – consists of photoreceptors, the light detecting cells of the retina. It is located posteriorly and laterally in the eye.

Anteriorly, the pigmented layer continues but the neural layer does not – this is part is known as the **non-visual retina**. Posteriorly and laterally, both layers of the retina are present. This is the **optic** part of the retina.The optic part of the retina can be viewed during ophthalmoscopy. The centre of the retina is marked by an area known as the **macula**. It is yellowish in colour, and highly pigmented. The macula contains a depression called the **fovea centralis**, which has a high concentration of light detecting cells. It is the area responsible for high acuity vision. The area that the optic nerve enters the retina is known as the optic disc – it contains no light detecting cells.