- **The ear is an organ with 2 functions:**
  - Hearing.
  - Maintenance of equilibrium/balance.

- **The ear is divided into 3 parts:**
  - External ear.
  - Middle ear (which is also known as tympanic cavity).
  - Inner ear (which is also known as labyrinth).

- **External ear (composed of the auricle, external auditory canal and outer portion of tympanic membrane):**
  - **Auricle:**
    - It is composed of elastic cartilage and functions in collecting sound waves.
    - It has many parts:
      - Helix.
      - Antihelix.
      - Tragus.
      - Antitragus.
      - Lobule.
    - The auricle has a thin skin which lacks a fatty layer and composed of 1 layer of blood vessels.
    - **Muscles of the auricle:** anterior, posterior and superior auricular muscles which are innervated by the facial nerve (7th CN).
    - **Arterial supply:**
      - Anterior auricular artery: from superficial temporal artery.
      - Posterior auricular artery: from external carotid artery.
    - **Innervation:**
      - Auricular branch of the vagus nerve (X).
      - Auriculotemporal branch of mandibular nerve (V3).
      - C2 and C3
    - **Lymphatic drainage:**
      - Superficial parotid lymph nodes.
      - Superficial cervical lymph nodes.
      - Mastoid lymph nodes.

- **External auditory canal:**
  - It is an S-shaped, curved tube which is 2-3 cm in long.
  - It is composed of:
    - A cartilaginous (elastic) portion in the outer 1/3: this portion contains skin, hair, sebaceous glands and ceruminous glands.
    - Osseous portion in the inner 2/3: formed by the tympanic membrane. Notice that ceruminous glands are absent in this portion.
  - **Function:** conducting sound waves and vibrations from the auricle to the tympanic membrane.
  - **Arterial supply:**
    - Superficial temporal artery.
    - Posterior auricular artery.
    - Deep auricular branch of maxillary artery.
  - **Innervation:**
    - Auricular branch of vagus nerve (X).
    - Auriculotemporal branch of mandibular nerve (V3).

- **Tympanic membrane:**
  - It is composed of 3 layers:
- **Outer layer**: stratified squamous epithelium (thin skin).
- **Middle layer**: fibrous. The area containing fibrous layer is known as pars tensa while the area which is devoid of fibrous layer is known as pars flaccida.
- **Inner layer**: cuboidal epithelium.

- **In otoscopy**: It is cone-shaped, pearly gray in color, positioned obliquely, concave from outside and convex from inside.

- **Innervation**:
  - **Externally**:
    - Auricular branch of vagus nerve (X).
    - Auriculotemporal branch of mandibular nerve (V3).
  - **Internally**:
    - Glossopharyngeal (IX).

- **Middle ear**:
  - **It is composed of 2 parts**:
    - Tympanic cavity proper.
    - Epitympanic recess: where the bodies of the incus and malleus are located.
  - **Function**: transmission of vibrations from tympanic membrane.
  - **Boundaries**:
    - **Roof**: tegmen tympani (a thin part of the temporal bone).
    - **Floor**: jugular wall (in relation to the internal jugular vein).
    - **Medial wall**: promontory (projection formed by the cochlea).
    - **Lateral wall**: tympanic membrane.
    - **Anterior wall**: auditory tube + canal of tensor tympani.
    - **Posterior wall**: aditus to antrum + pyramid of stapedius.
  - **Pharyngotympanic tube**:
    - It is connecting the tympanic cavity to the nasopharynx.
    - It functions to equalize pressure in the middle ear with atmospheric pressure and balances it on both sides of the membrane (this is associated with activities such as swallowing and yawning).
  - **Arterial supply**:
    - Ascending pharyngeal artery: branch of external carotid artery.
    - Middle meningeal artery.
  - **Venous drainage**:
- **Pterygoid venous plexus.**
  - **Innervation:** tympanic plexus (from CN IX).
  - **Lymphatic drainage:** deep cervical lymph node.

- **Auditory ossicles:**
  - There are 3: malleus, incus and stapes.

- **Muscles of the tympanic cavity:**
  - **Tensor tympani:** it dampens the vibrations of the malleus and is innervated by mandibular division of trigeminal nerve (5th CN).
  - **Stapedius:** it dampens the vibrations of the stapes and is innervated by facial nerve (7th CN).
  - **Arterial supply:**
    - Tympanic branch of maxillary artery.
    - Stylomastoid branch from posterior auricular artery.
  - **Venous drainage:**
    - Pterygoid plexus.
    - Superior petrosal sinus.
  - **Innervation:**
    - Tympanic plexus.

- **Inner ear:**
  - **The bony part:**
    - It contains the perilymph (which has Na⁺).
    - It is composed of 3 parts:
      - **Vestibule:** which contains the utricle and saccule and concerned with balance.
      - **Semicircular canals:** these are 3 (superior, posterior and lateral).
      - **Cochlea:** a spiral shell making 2.5 turns around a central bony pillar called the modiolus where the nerve cell bodies of the cochlear nerve are located. The cochlea is concerned with hearing and the tube is divided into 3 cavities:
        - Scala vestibule.
        - Scala media.
        - Scala tympani.
Note: scala vestibule and scala tympani merge with each other at helicotrema.

- **The membranous part:**
  - It contains the endolymph (which has $K^+$).
  - It is composed of 3 parts:
    - *Utricle and saccule.*
    - *Semicircular ducts:* well-innervated hair cells have long stereocilia embedded in a viscous fluid. Movement of this fluid under the influence of gravity and momentum bends the hairs triggering a nerve impulse which passes into the CNS along the vestibular nerve → to vestibular nucleus (which is located in the lateral part of the floor of the 4th ventricle).
  - *Cochlea:*
    - Cochlea is divided into its 3 cavities by 2 membranes: basilar and Reissner's.
    - Inner and outer hair cells are present in the middle cavity (scala media) which contains endolymph.
    - Tectorial membrane is present at the superior aspect of inner and outer hair cells.
    - Inner hair cells are those which are responsible for hearing and resting on the basilar membrane.
    - When vibrations reach the basilar membrane → inner hair cells will move → their stereocilia will be bent by tectorial membrane → leading to influx of potassium from endolymph → resulting in depolarization and generation of actions potentials which will travel through cochlear nerve.

- **Arterial supply:**
  - Internal auditory artery (basilar artery).
  - Stylomastoid artery (posterior auricular artery).

- **Venous drainage:**
  - Internal auditory vein.
  - Superior petrosal sinus/ transverse sinus.

- **Transmission of sound:**
  - Sound waves → pinna → external auditory canal → tympanic membrane → ossicles vibrate → pressure waves in the perilymph → moves basilar membrane → stimulate hair cells → auditory nerve → medila geniculate body → temporal lobe.

- **Facial nerve (7th cranial nerve):**
  - **Supplying:** muscles of facial expression (frontalis, orbicularis oculi, baccinator, levator angularis, nasalis and orbicularis ori) + stapedius + stylohyoid + posterior belly of digastrics muscle.
  - **Course of the nerve:** it is originating laterally in pontomedullary junction (accompanied by nervus intermedius) → enters the internal auditory canal with
vestibulocochlear nerve → at the lateral end of the canal facial nerve turns sharply backward above tympanic cavity (forming the genu which contains the geniculate ganglion for the sensory component) → then it turns sharply downward behind tympanic cavity → emerging through stylomastoid foramen → going to parotid gland → where it breaks up into its major branches

- **Nervus intermedius:**
  - Carrying preganglionic parasympathetic fibers from superior salivary nucleus in pons to:
    - Pterygopalatine ganglia → going to lacrimal glands.
    - Submandibular ganglia → going to submandibular and sublingual salivary glands.
  - It is also carrying taste from anterior 2/3 of the tongue → to geniculate ganglion → to nucleus solitarius in rostral part of medulla oblongata.

- **Cochlear nerve (branch of 8th cranial nerve):**
  - Course: cochlear nerve from both ears end in cochlear nuclei → second order neurons will cross (forming trapezoid body) and then fibers will ascend → to reach superior olivary nucleus which helps in determining the source of the sound and giving branches to the following:
    - 3rd, 4th and 6th cranial nerves → causing movement of eyes in response to sound.
    - 5th and 7th cranial nerves → initiating the protective reflex contraction of tensor tympani and stapedius.
    - Inferior colliculus → fibers from here will project to medial geniculate body of thalamus → and then to the primary auditory cortex in the upper surface of superior temporal gyrus → from here fibers will project to auditory association cortex (Wernicke’s area) for interpretation of the information.