

**Done by:**

- **Summary:** Norah AlRomaih
- **MCQs:** Norah AlRomaih - Munira Alhussaini - Wael AlOud

## Summary!

### ❖ the Functions of the ear:

Hearing (parts involved)	Equilibrium sense (parts involved)
a. <b>External</b> ear. b. <b>Middle</b> ear. c. <b>Internal</b> ear (cochlea).	Internal ear ( <b>semicircular canals</b> , the <b>utricle</b> and the <b>sacculle</b> ).

### ❖ Nature of the sound:

- alternate **compression** and **rarefaction** of air molecules by vibrating body.

### ❖ Characteristics of sound:

Characteristics:	depends on:
Pitch (Tone)	number of <b>cycle/sec</b>
Intensity(Loudness)	<b>amplitude</b> (low amplitude = soft, high amplitude= high)
Quality	<b>overtone</b> or <b>interference</b>

\*Human ear can detect sound waves with frequency **20-20000 cycle /sec\***

### ❖ External ear:

Components	Functions
1- Pinna. 2- External auditory canal (External auditory meatus). 3-Tympanic membrane "ear drum"	1. Act as funnel to <b>collect</b> sound. 2. Sound <b>localisation</b> (front,back,high,low). 3. <b>Protection</b> .

### ❖ Middle ear:

- located between **tympanic membrane** and the **inner ear**.
- It opens via **Eustachian tube** into **nasopharynx** "It equalizes the pressure between the outside and inside pressure"
- **content:**
  - **Air**
  - Ossicles: **Malleus, Incus, Stapes**.
  - Muscles: **Tensor tympani, Stapedius**.

- **Function:**

Protection effect against constant loud noise-Muscles	Middle ear magnifying effect:	Transmission of sound through the middle ear:
<p>-These Muscles contract reflexly in response to loud sound (<b>over 70dB</b>).</p> <p>* <b>How?</b></p> <p>-<b>Contraction of the tensor tympani</b> pulls the manubrium &amp; makes the tympanic membrane tensed, Thus <b>decreasing</b> the vibration.</p> <p>-<b>Contraction of the stapedius</b> pull the foot plate outward, so that vibration are <b>reduced</b>.</p>	<p><b>1.</b> The force from Tympanic membrane is concentrated to a oval window. <b>the ratio is 17/1</b> "The tympanic membrane is 17 times wider than the oval window, the sound will get concentrated as it pass".</p> <p><b>2.</b> Lever action of ossicles = the lever action of ossicles increase the force of movement <b>1.3 times</b>. *the total increase <math>17 \times 1.3 = 22x^*</math></p>	<p>Sound waves <b>vibrate</b> the tympanic membrane → Tympanic membrane <b>moves</b> the <b>handle of malleus</b> → <b>Incus</b> moves → <b>Stapes</b> move in &amp; out of the <b>oval window</b> → The pressure transmitted through cochlea cause <b>stimulation of hair cells</b> in the organ of corti, which will <b>stimulate the auditory nerve</b>.</p>

#protection from **constant** loud noise, **but not sudden** noise, **latency of 40-80 6 msec.**

❖ **Inner ear:**

- **Anatomy:** **Bony labyrinth, Membranous labyrinth & cochlea**"snail like, coiled tubular system lying deep in the temporal bone"
- **cochlea:**
  - It is a system of three coiled tubes through its length .
  - The **basilar membrane & the Reissner's membrane** divide it into three canals:

		1-Scala Vestibuli	2- Scala Media	3- Scala Tympani
composition	Na	high	low	high
	K	low	high	low
	Similar to	Similar to the ECF	Similar to the ICF	Similar to the ECF

- **Organ of Corti:**

- Located (resting) on the **basilar membrane** and it is extended from base to apex .
- This structure contains highly specialized auditory receptors called: **inner & outer hair cells**.

- **Hair cells:**

- **Arrangement:** arranged in **4 rows** (**Three** rows of outer hair cells & **One** row of inner hair cells).
- **Types:**

Outer hair cells	Inner hair cells
Stereocilia is <b>Attached</b> to the reticular lamina (tectorial membrane).	Stereocilia is <b>Not attached</b> to tectorial membrane.
- <b>Functions</b> of the outer hair cells: <b>1</b> -Large number, but stimulate only small fraction of nerve fibres in the cochlear nerve. <b>2</b> -If damaged, significant loss of hearing. <b>3</b> -they control the sensitivity of inner hair cells to particular sound frequency.	- <b>Functions</b> of the outer hair cells : <b>1</b> -Striocellia not embedded in tectorial membrane, but bent by fluid movement 9 under the tectorial membrane (between the tectorial membrane and underlying hair cells.) . <b>2</b> -They are <b>primary receptors for sound "hearing"</b> , transducing fluid movement in cochlea into action potential in the auditory nerve

## ❖ Receptors & Endocochlear potentials:

1. Sound transmission into the inner ear cause upper & lower movements of the reticular membrane (tectorial membrane).
2. Produce bending of stereocilia of the hair cells alternatively open & close cation channels at the tip of the stereocilia.
3. (inward current) depolarization (outward current) hyperpolarization the net results is depolarization.
4. Production of cells receptors potentials.
5. Release of neurotransmitter.
6. Production of action potentials.

## ❖ The Central Auditory pathway:

- This pathway **begins in the organ of corti.**
- **End in the primary auditory cortex** (area 41 & 42 , superior temporal gyrus in the 10 temporal lobe of the brain)
- **Fibres end in the auditory area**, where it is heard, then interpretation occurs in the auditory association 11 areas (wernicke's area).
- There is a **bilateral cortical connection** of auditory area
- Thus **damage to one side only slightly reduces hearing.**

## ❖ Sound localization:

- **depends on:** Differences in the time arrival of the sound wave at the ears (time-lag) & Differences in the loudness.

## ❖ Masking effect:

- Presence of background noise affect the ability to hear another sound, due to some receptors are in **refractory period.**
- Masking is **more clear** if two sound are having the **same frequencies.**
- Noise pollution is an environmental hazard.
- Exposure to sound intensity **above 80dB** may damage outer hair cells.

### **# Important!!**

Every area in the cochlea is responsible for specific frequency

★ **High** frequencies sound waves will stimulate hair cells at the **base.**

★ **Low** frequencies sound waves will stimulate hair cells at the **apex.**

## ❖ Conduction of a sound wave:

<b>Air conduction:</b>	<b>Bone conduction:</b>
<p>- Normal situation of hearing, sound travel in air causes vibration of <b>Tympanic m.</b>, transmitted by ossicles to the oval window.</p> <p>- It is the main conduction pathway of hearing in humans.</p>	<p>Sound cause vibration of <b>skull bones</b> directly transmitting the sound vibration to the cochlea (eg when placing tuning fork on the head or mastoid process).</p>

## ❖ Test of hearing:

1. **Audiometer.**
2. **Weber** test.
3. **Rinne's** test:
  - Normal subject continue to hear near ear (**positive test**).
  - If not reverses the test (if heard near the mastoid process, **negative test**).

## ❖ Deafness:

Conductive deafness	Perceptive deafness
Impairment of sound transmission through external or middle ear <u>due to</u> : <b>Wax, Repeated infection, Perforated drum, Destruction of ossicles, Osteosclerosis</b> (pathological fixation of stapes on the oval window).	Due to congenital or damage to cochlea or auditory nerve pathway <u>due to</u> : <b>Toxins</b> (antibiotics, gentamicin), <b>Inflammation, Vascular, Tumour</b>
- All sound frequencies <b>are equally affected</b> . - <b>Bone</b> conduction <u>is better</u> than air conduction	<b>Both</b> air and bone conduction are affected

## Check your understanding!

<b>1- : all the following are parts of Equilibrium sense EXCEPT:</b>		<b>2- : Quality of sound depends on:</b>	
A	semicircular canals	A	overtone
B	cochlea	B	amplitude
C	utricle	C	interference
D	saccule	D	both A&C
<b>3- Human ear can detect sound waves with frequency:</b>		<b>4- Functions of external ear are:</b>	
A	30-20000 cycle /sec	A	collect sound
B	20-30000 cycle /sec	B	Protection effect against constant loud noise-Muscles
C	20-20000 cycle /sec	C	Sound localisation
D	50-20000 cycle /sec	D	both A&C
<b>5- magnifying effect is function of:</b>		<b>6- composition of Scala Media:</b>	
A	Middle ear	A	Na low, K high
B	External ear	B	Na high, K low
C	inner ear	C	both Na & K high
D	Tympanic membrane	D	both Na & K low
<b>7- Organ of corti Located on:</b>		<b>8- Arrangement of hair cells:</b>	
A	Reissner's membrane	A	Two rows of outer hair cells, One row of inner hair cells.

B	basilar membrane	B	Three rows of outer hair cells, two row of inner hair cells.
C	Tympanic membrane	C	One rows of outer hair cells, three row of inner hair cells.
D	Auditory membrane	D	Three rows of outer hair cells, One row of inner hair cells.
<b>9- High frequencies sound waves will stimulate hair cells</b>		<b>10- Normal situation of hearing, sound travel in air causes vibration of Tympanic membrane is:</b>	
A	at the base of semicircular canals	A	Air conduction
B	at the apex of semicircular canals	B	bone conduction
C	at the base of cochlea	C	Both A&B
D	at the apex of cochlea	D	Non of the above
<b>11- Due to congenital or damage to cochlea or auditory nerve pathway due to Vascular is:</b>		<b>12- Masking effect is more clear if two sound are having the.....</b>	
A	Conductive deafness	A	different frequencies
B	Perceptive deafness	B	Same frequencies
C	Sensori-neural deafness	C	Same Intensity
D	Both A&C	D	different Intensity

**Answers :**

<b>1- B</b>	<b>2- D</b>	<b>3- C</b>	<b>4- D</b>	<b>5- A</b>	<b>6- A</b>	<b>7- B</b>	<b>8- D</b>	<b>9- C</b>	<b>10- A</b>	<b>11-B</b>	<b>12-B</b>
-------------	-------------	-------------	-------------	-------------	-------------	-------------	-------------	-------------	--------------	-------------	-------------