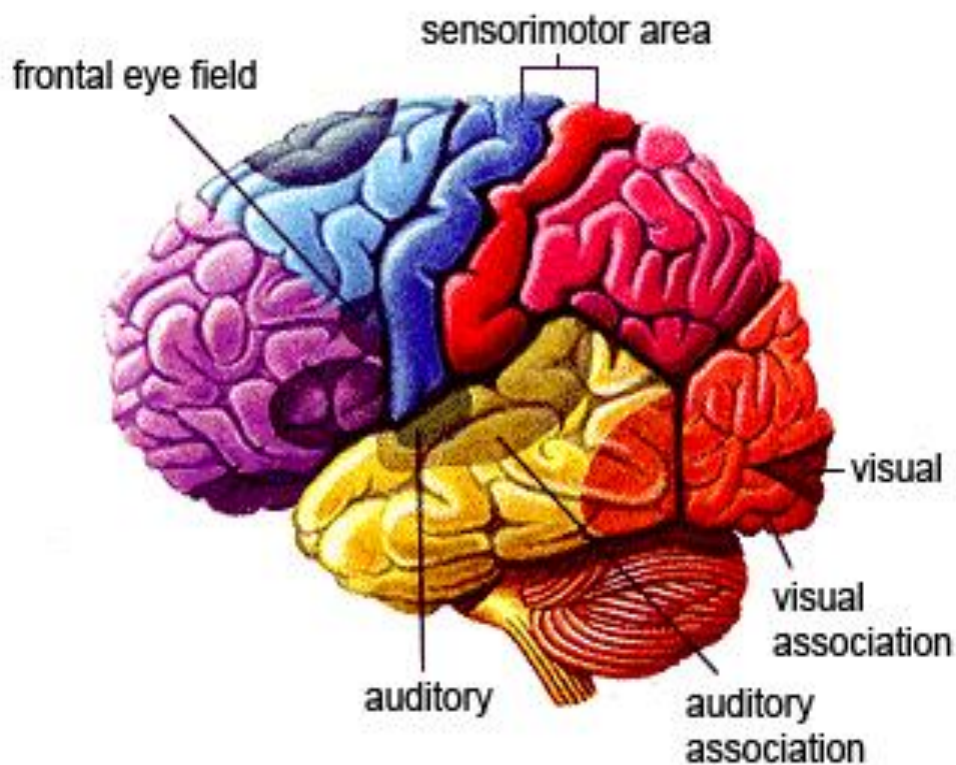


Physiology Team



Amna Baljoun

Ahlam Al –Maawi

Areej Al Kahtani

Bodoor Al Tayeb

Asmaa` Bedawi

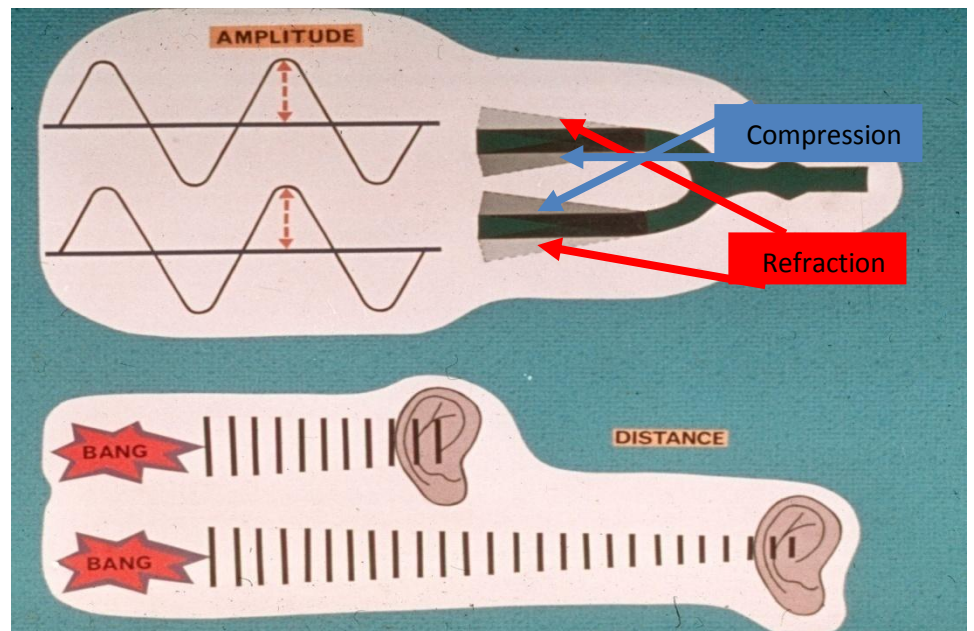
Asma Al Mahdi

(these notes are combination of female and male slides + our notes)

Physiology of Hearing

***Stimulus:** Sound or vibration

***Alteration
between
compression and
refraction
creates the
sound waves.**



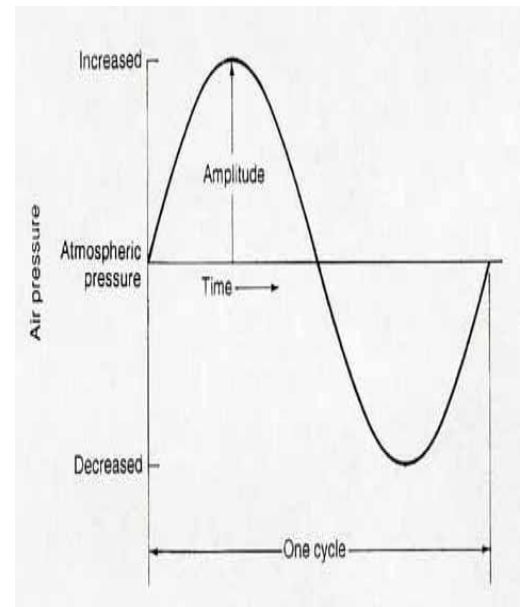
Basic properties of sound of sound waves

❖ Amplitude:

(length or height of the sound wave) = Intensity
= (Loudness)

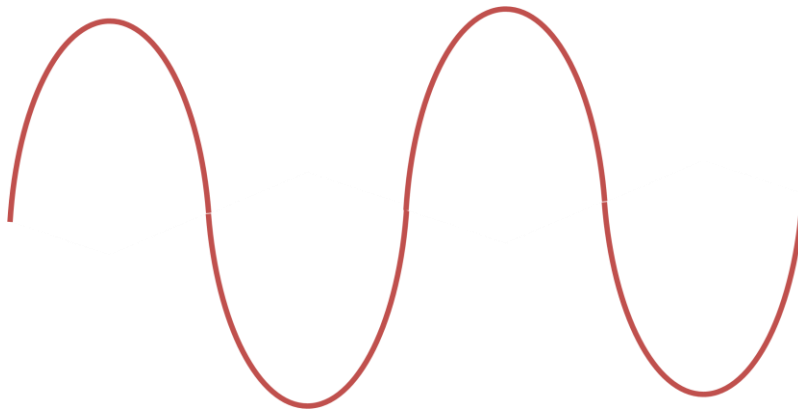
- Low sounds has low amplitudes, and high sounds have high amplitudes.

- **Amplitude:**
the objective measurement of the degree of change (positive or negative) in atmospheric pressure (the compression and rarefaction of air molecules).



Loudness of sound:

This sound wave has a high amplitude (loud):



• This sound wave has a low amplitude (quiet):



- ❖ **Frequency:** = Pitch = tone
Is Number of cycles per second.
Unit: Hertz (hz)

Frequency of sound:

- This sound wave has a high frequency:



- This sound wave has a low frequency:



Measuring scale:

1 decibel(dB) = 0.1Bel

Decibel: is a unit to measure sound as a whole wave
(frequency + amplitude).

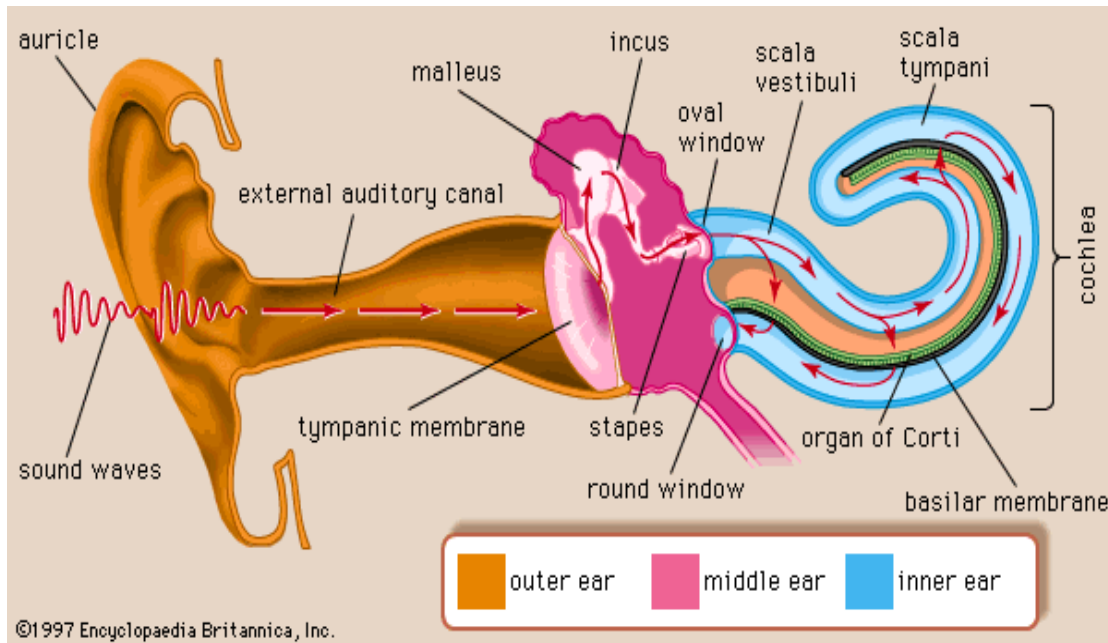
(Decibel Scale)

Sound	Rating (dB)
Absolute silence	0
Whispering	15
Automobile(cars) 30 ft	60
Conversation- 3ft	40-45
Loud conversation	70
Loud radio	80
Pneumatic hammer (drills) 3ft	120
Jet aircraft at takeoff	150+

 *Because it starts with a high amplitude and frequency then decreases when it takes off.

***Sounds > 80 dB are considered noise pollution.**

Mechanism of hearing



Sound wave → enters the ear lobule → Ear canal → vibration of the tympanic membrane → Vibration of the 3 bones; malleus, incus, and stapes → goes into the oval window → enters the inner ear → hair cells → **Hearing.**

Physiology of the ear

A) External ear:

Function:

- 1) **Detection** (localization) & **collection** of sound waves.

Ex. If someone is talking in front of you, you hear his voice better than the one talking behind you, because the sound is delayed due to the shape of the ear auricle.

- 2) Concentration of sound waves in the external auditory meatus
- 3) Humidification of air.
- 4) Protection of inner parts.

- Tympanic membrane (Ear drum):

- *Properties:-

- 1) Resonator:

Vibrates at the same frequency as the sound waves. **Ex.** 5 cycles = 5 vibrations of the tympanic membrane.

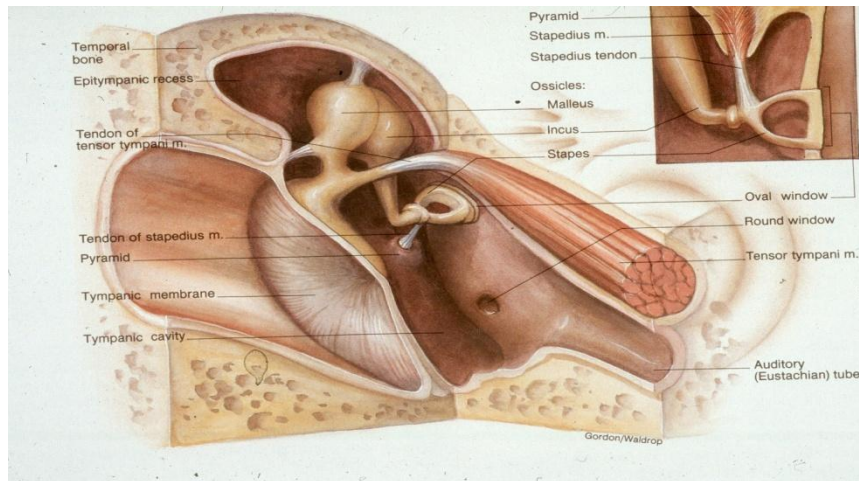
- 2) Critical damping:

The tympanic membrane stops vibrating once the stimulus has stopped.

*Animals, such as bats and dogs, are very sensitive to sounds due to the shape and size of their ears, and the sizes of their tympanic membranes.



B) The Middle Ear



It's an **air-filled cavity**. It contains **3 bones + 2 muscles**.

The 2 muscles are:

1. Tensor tympani:

attached to the tympanic membrane. It applies tension on the tympanic membrane when it's contracted.

2. Stapedius:

attached to stapes bone. It functions by separating the stapes bone from the oval window when it contracts.

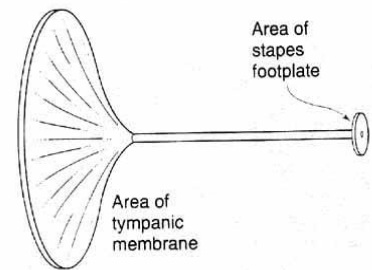
Function: (of the middle ear)

- 1) Transmission of sound to the inner ear.
- 2) Protection from loud continuous noise.
- 3) Amplification of sound waves (magnification)
(x 22 times).

* How the middle ear magnify sound waves?

1. Concentration of force:

Due to the size of the tympanic membrane which is **17 times** greater than the oval window (Amplification due to difference in area size).



2. Leverage(Lever system):

The force increases when it moves from big objects to smaller ones (the ossicles)

malleus(big) → incus(smaller) → stapes(much more smaller)

Leverage Principle:

By using leverage it is possible for a very small force to move a big object. It multiplies the pressure of the sound wave exerted against the tympanic membrane, and increases the force of movement about **1.3 fold**.

❖ So amplification (magnification) of sound:

- 1) Area of ear drum 55mm²
Area of oval window 2.5mm²

amplification due to difference in areas is 17 times.

- 2) Ossicles (Lever system)

amplify sound 1.3 times

❖ Total amplification of sound
 $1.3 \times 17 = 22$ times

• The Tympanic Reflex

It is a protective mechanism of the ear.
This reflex starts after 30-130 msec.

- It has two mechanisms:

- Loud continuous sound waves → contraction of tensor tympani → tympanic membrane becomes less funnel shaped → the space between the membrane and the malleus bone increases → and that cause low transmission of sounds.
- Loud continuous sound waves → contraction of the stapedius muscle → the space between the stapes bone and the oval window increases → low transmission of sounds between middle and inner ears.

*These 2 mechanisms happen at the same time.

***In sudden loud noises (explosions) :
damage to hair cells in the inner ear which is responsible for hearing. That happens because there is no protective mechanism.**