

9 mechanism of hearing

CNS

You have to study lecture “Anatomy of ear” **first**”

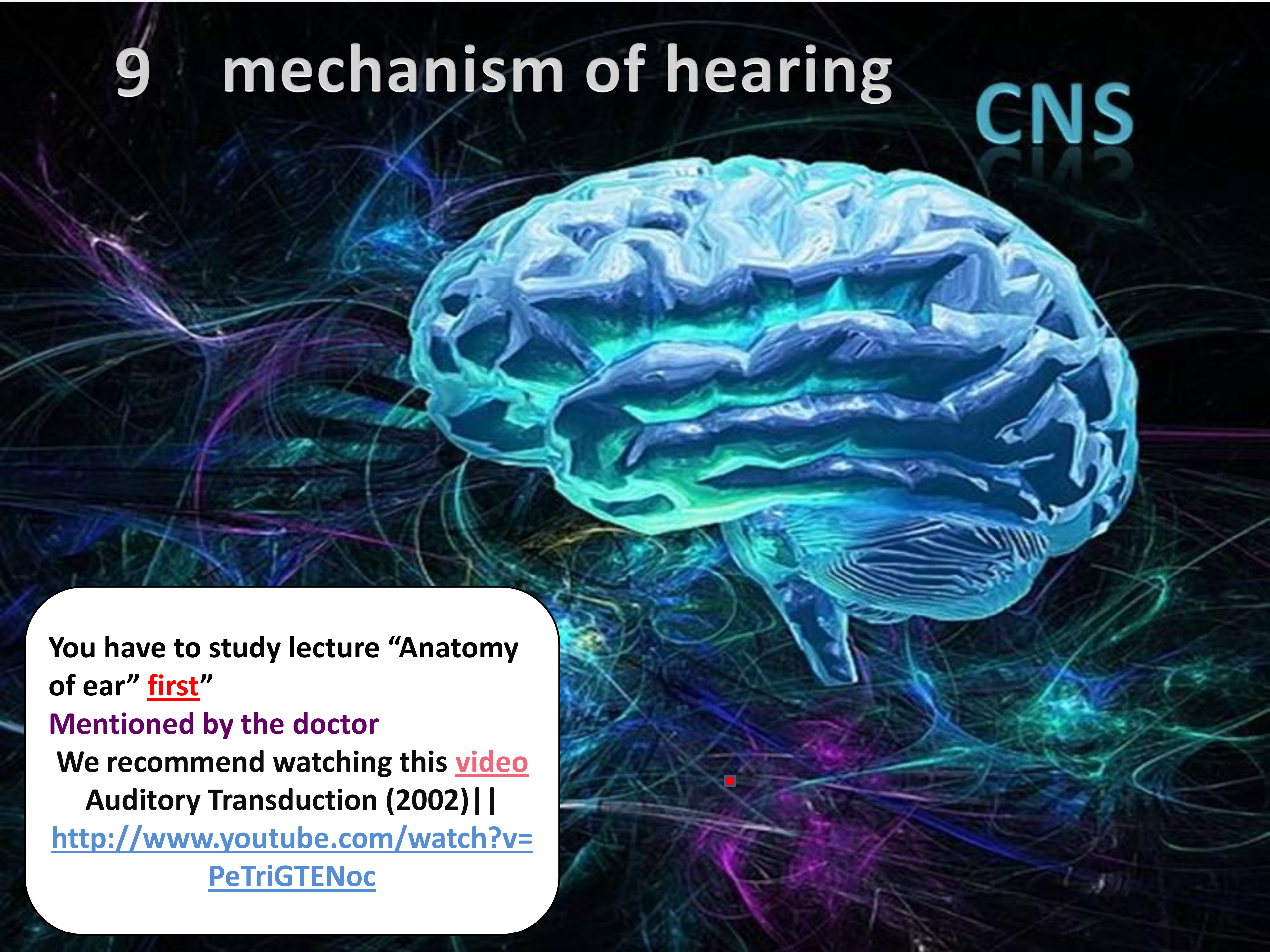
Mentioned by the doctor

We recommend watching this **video**

Auditory Transduction (2002) | |

[http://www.youtube.com/watch?v=](http://www.youtube.com/watch?v=PeTriGTENoc)

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(تنبيه)

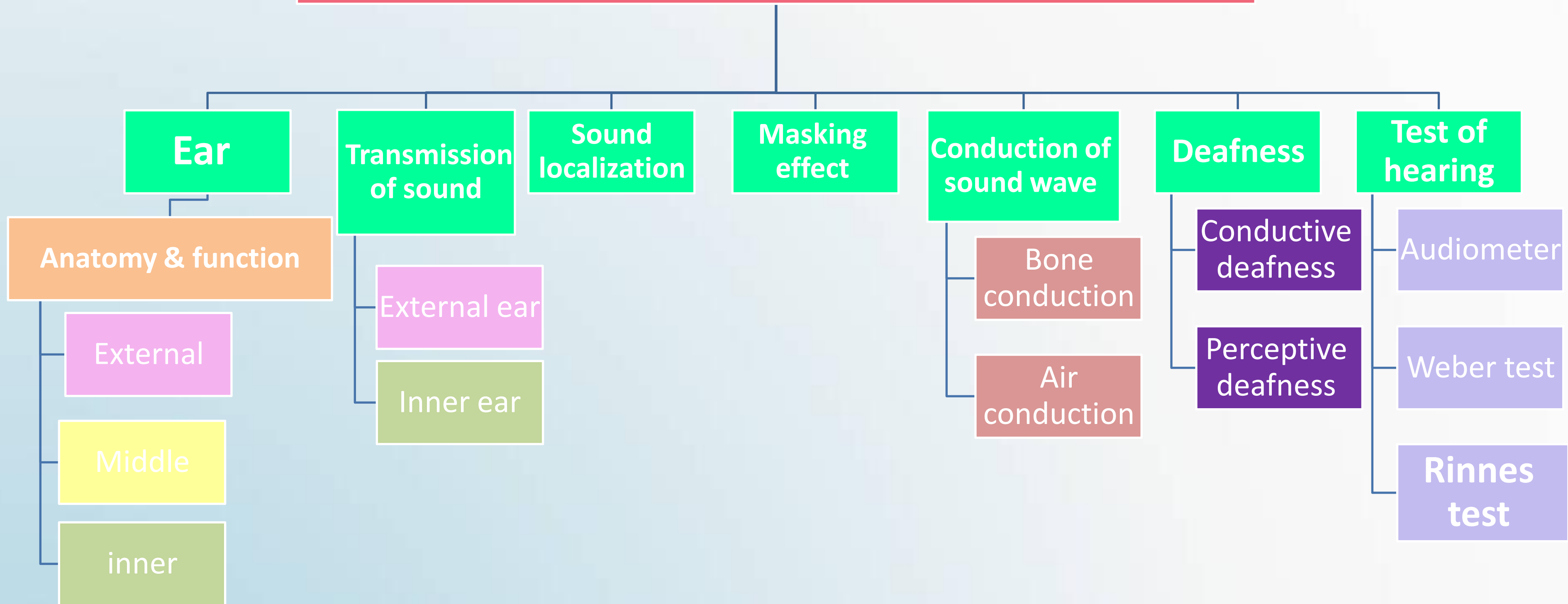
- سيتم إيضاح مصادر السلايدات في بداية كل محاضرة

- لن تكون هناك أسئلة نهاية كل محاضرة بل سيتم وضع أسئلة للمراجعة شامل قبل كل اختبار

- ينصح بمتابعة محاضرات الدكتور نجيب لهذا البلوك

[http://www.ksums.net/files/2nd/Archive/01%20CNS%20BLOCK/
Female/Physiology/Dr.%20Najeeb%20lectures/](http://www.ksums.net/files/2nd/Archive/01%20CNS%20BLOCK/Female/Physiology/Dr.%20Najeeb%20lectures/)

Mechanism of hearing



Functions of the ear

- **Hearing** (Parts involved):

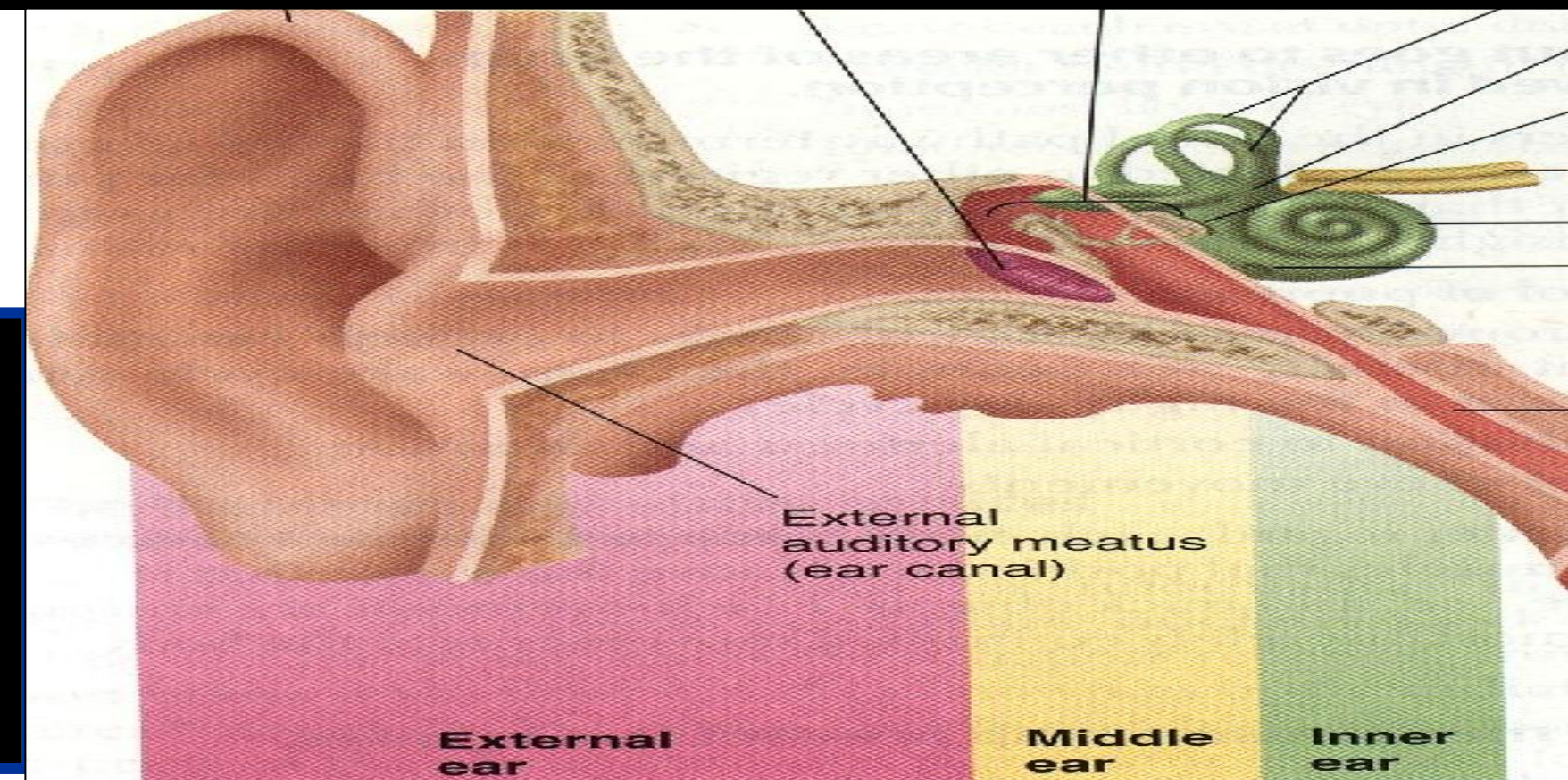
1. External ear

2. Middle ear

3. Internal ear

- **Equilibrium sense** (Parts involved):

1. Internal ear



Anatomy & Function

External ear:

Anatomy:

Pinna

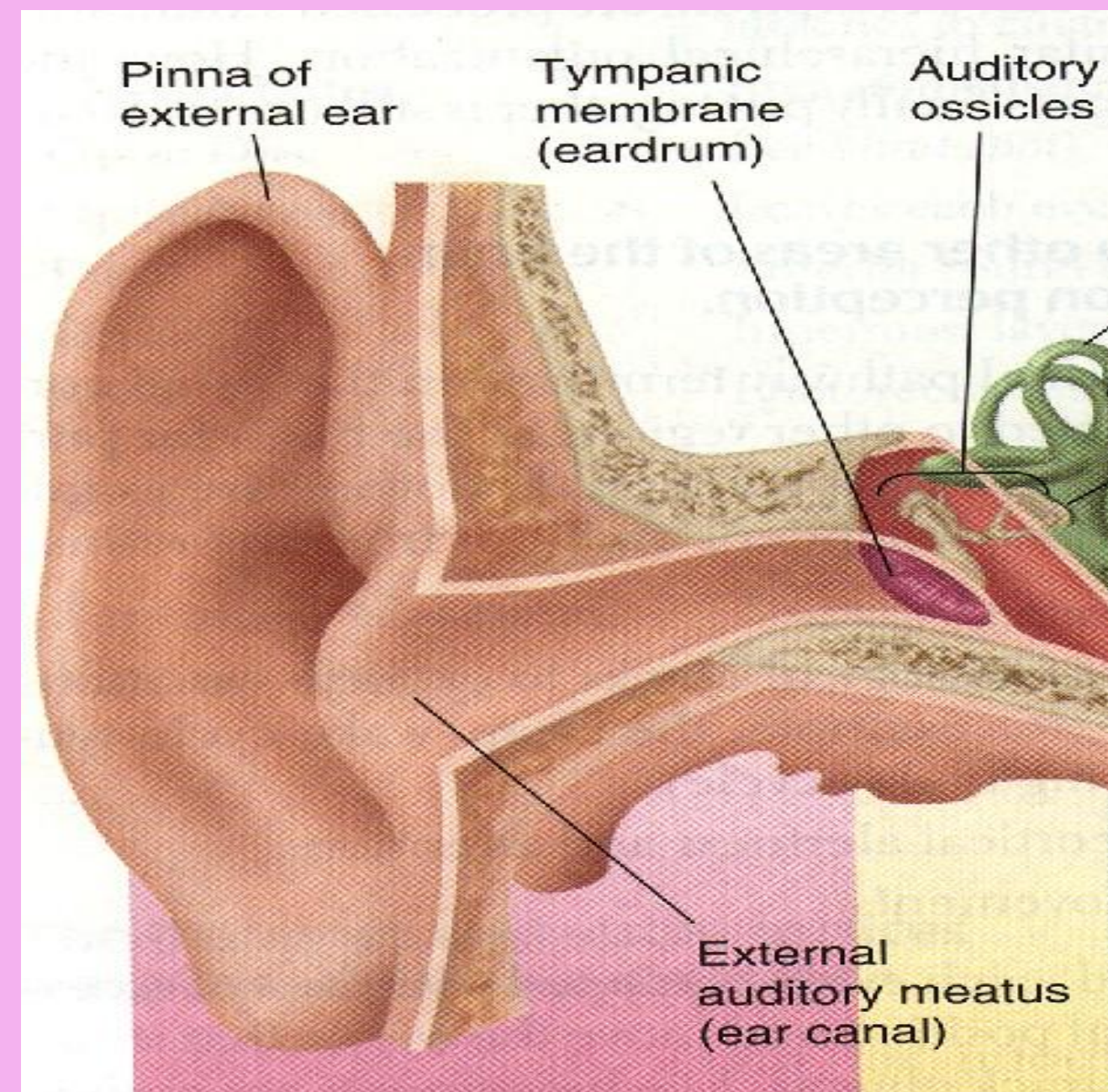
External canal

Tympanic Membrane (funnel shaped, pointing inward)

Function :

Act as funnel to collect sound

Sound localisation (front, back, high, low) Protection. + **warming the air**



Anatomy & Function

Middle ear:

it is a space between tympanic membrane and the inner ear (opens via Eustachian tube into **nasopharynx**)

Anatomy:

Air filled cavity

Three bones:

1- Malleus

2- Stapes (its foot sitting on the oval window of the inner ear)

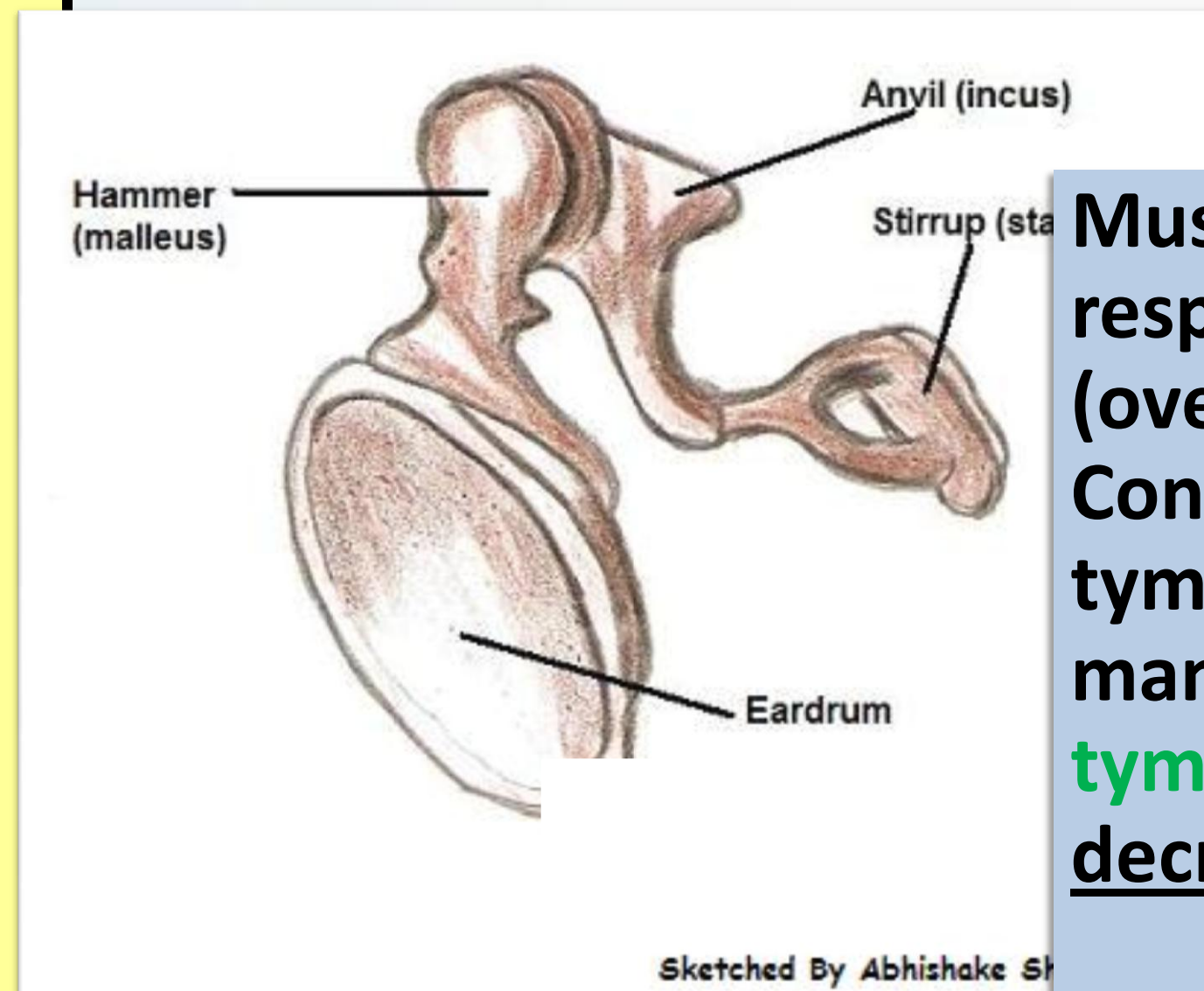
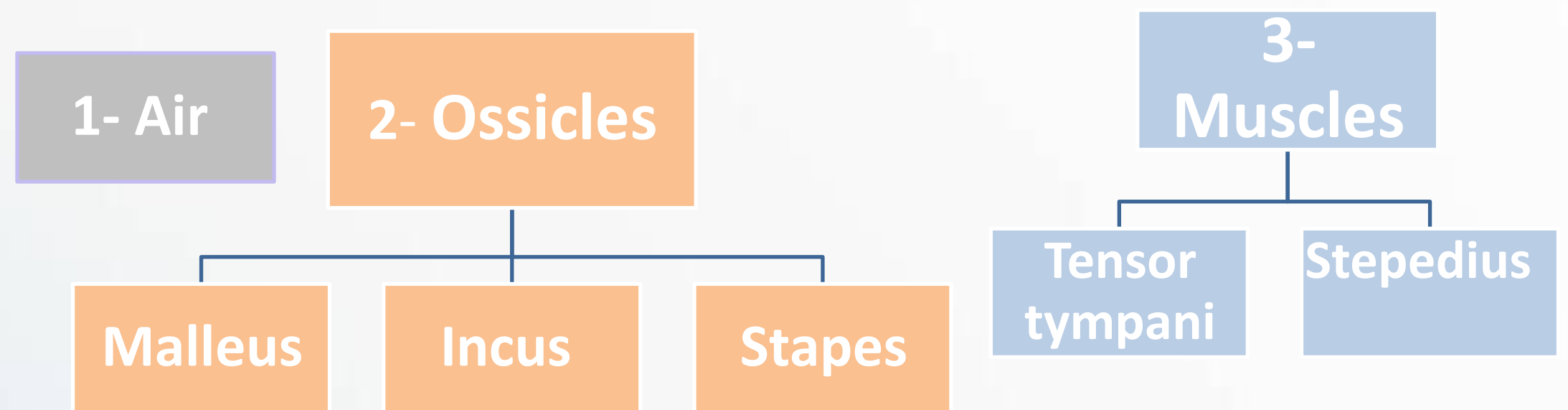
3- Incus

Function:

3 components

Manbrium of the **malleus** attached to the back of the tympanic membrane and its short process attached to the **incus**.

The **incus** then articulates with the head of the **stapes**, and its foot plate attached to the **oval window**



Muscles contract reflexly in response to loud sound (over 70dB) Contraction of the tensor tympani pulls the manubrium & **makes the tympanic m. tens.** Thus decreasing the vibration.

Contraction of the **stapedius** pull the foot plate outward so that vibration are reduced

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

Inner ear:

Fluid filled cavity

Anatomy:

- **Cochlea** (snail like, coiled tubular system laying deep in the temporal bone)
- **Bony and membranous** labyrinth

Cochlea

It is a system of three coiled tubes through its length.

The **basilar m.** & the **reissners m.** divide it into three canals:

Scala Vestibuli

Scala Media (cochlear duct):

It's Important because it has **organ of corti**

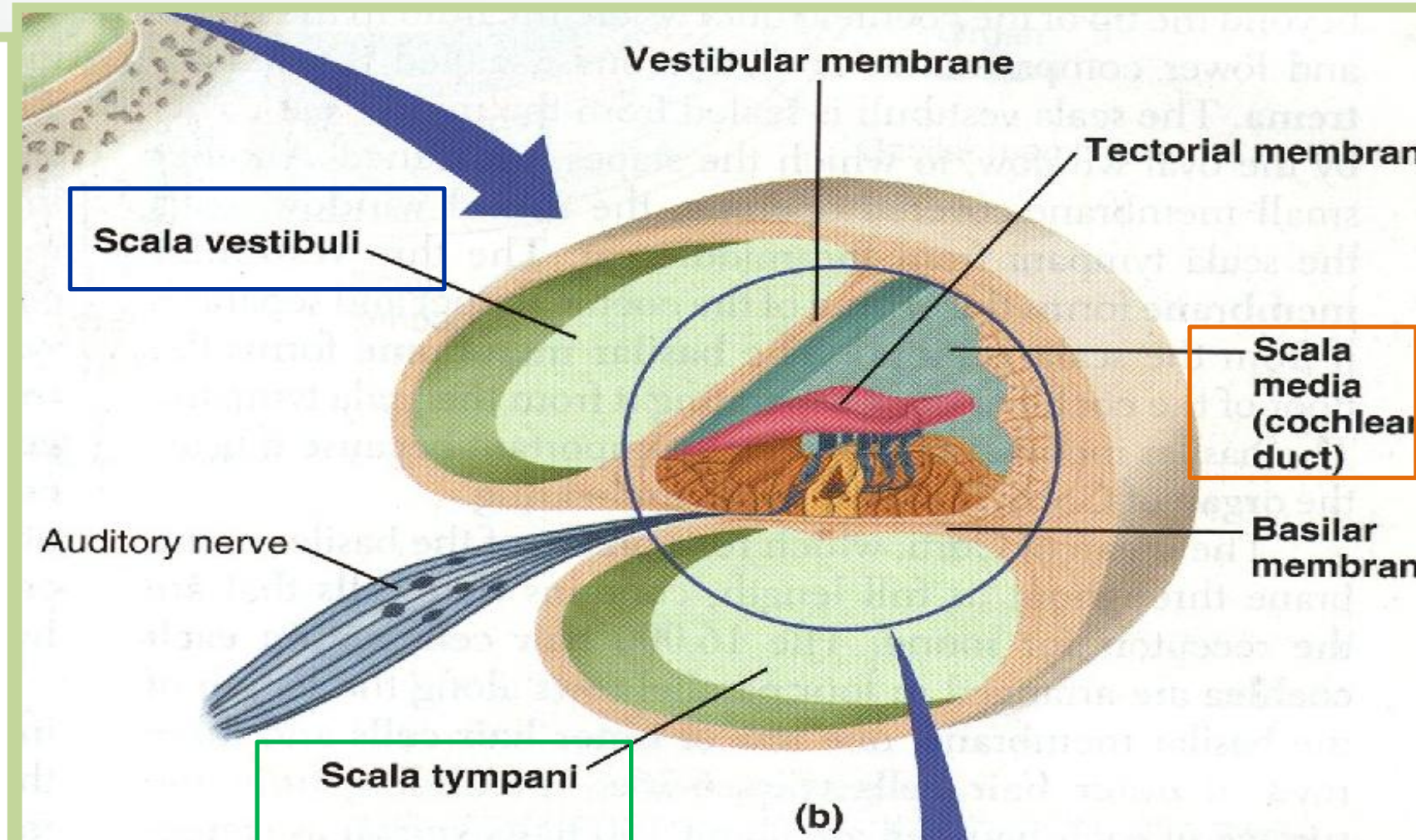
Scala Tympani

Organ of corti (three rows outer cells and one row inner)

Located (resting) on the **basilar membran.**

Contain **inner & outer** hair cells

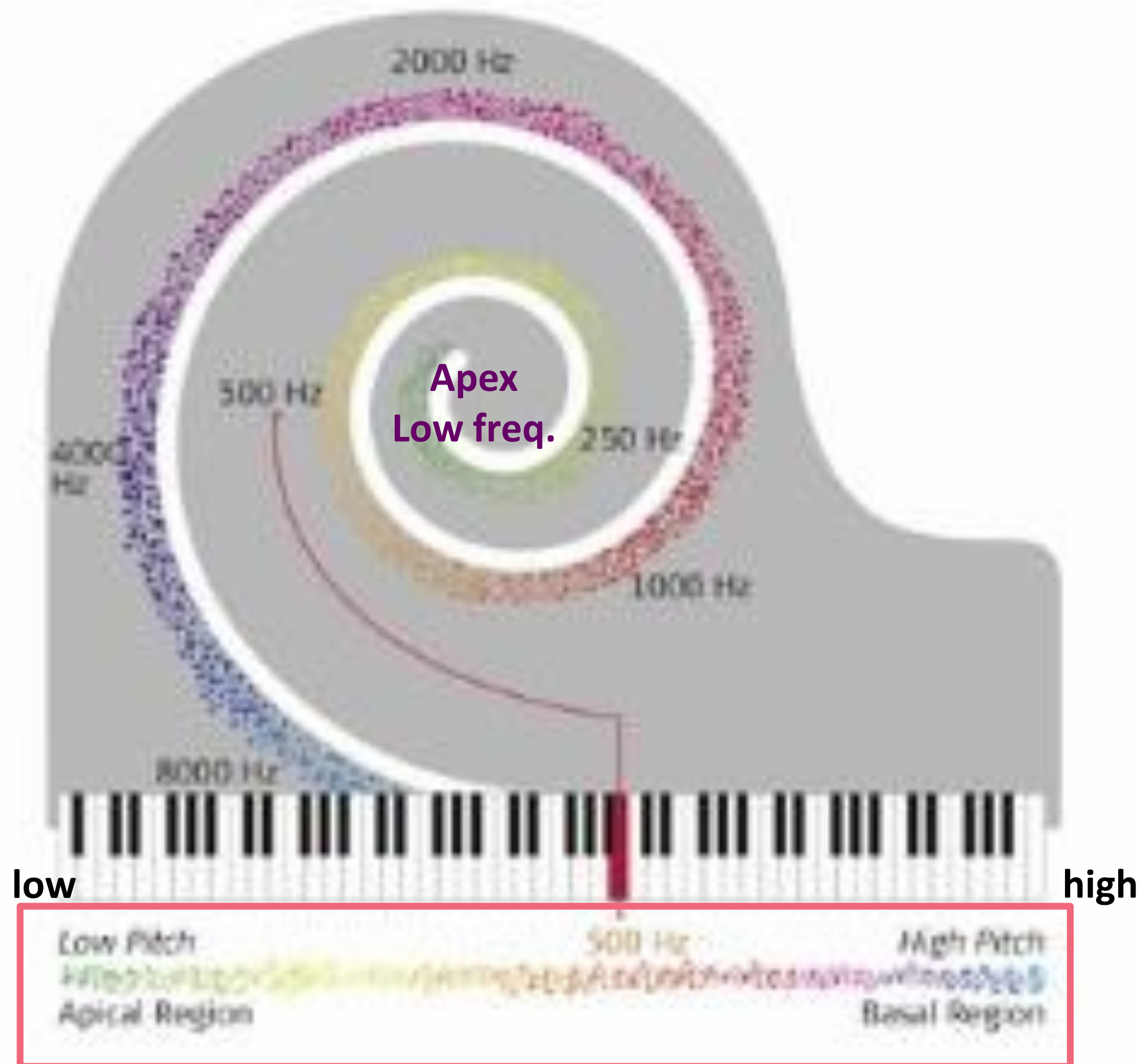
Extend from base to apex



Composition

Scala Vestibuli	Na high	K low
Scala Media <u>Similar to ECF</u>	Na high	K low
Scala tympani	Na low	K high

each part of **Cochlea** responsible for Different freq.



dB ديسبل وحدة قياس الصوت .
فوق 70
يعتبر الصوت
noise and dangerous



Sterocilia extend from the top.

Arrangement:

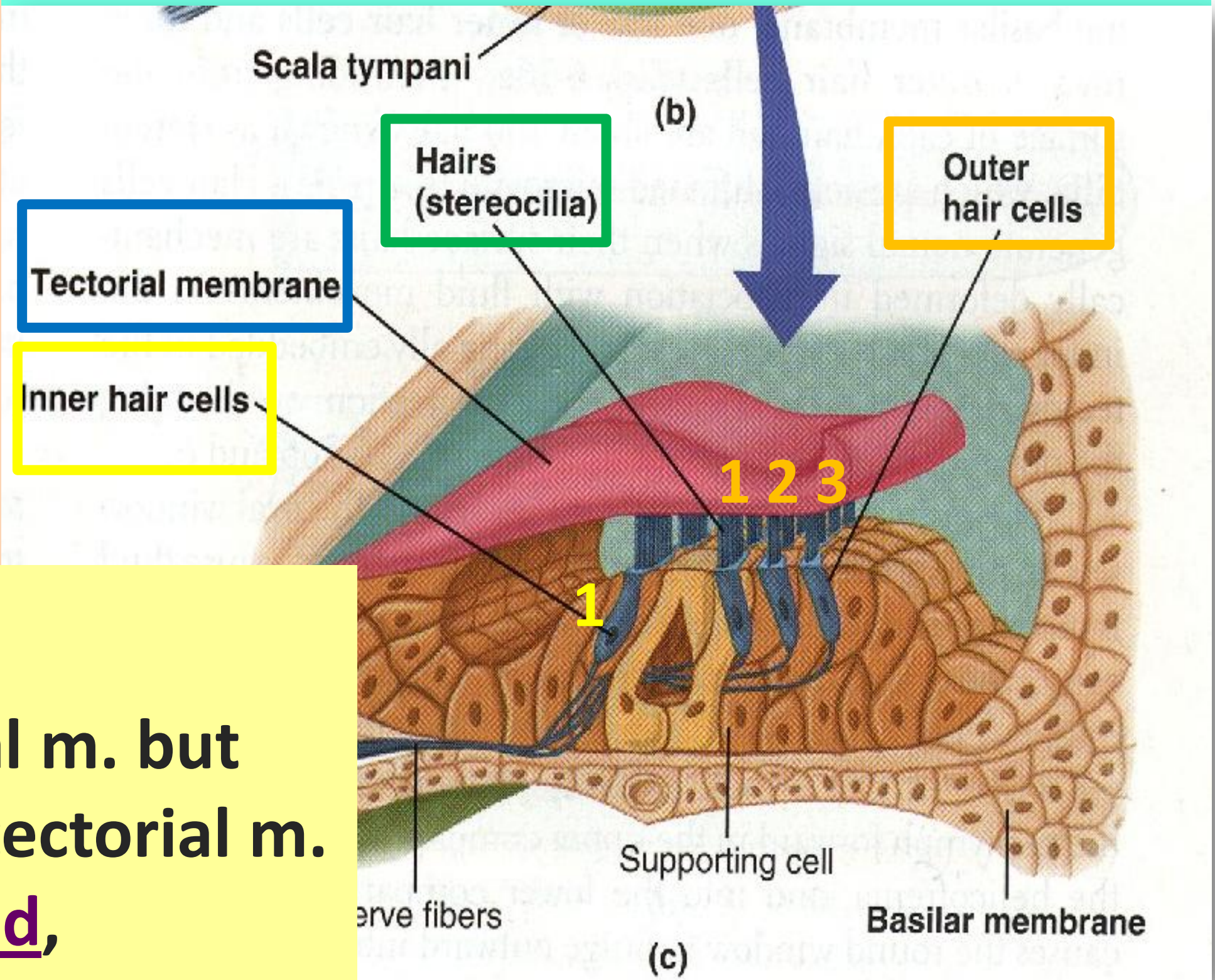
Three rows of **outer hair** cells
(attached to the reticular lamina or **tectorial m.**)

One row of **inner hair cells** (not attached to tectorial m.)



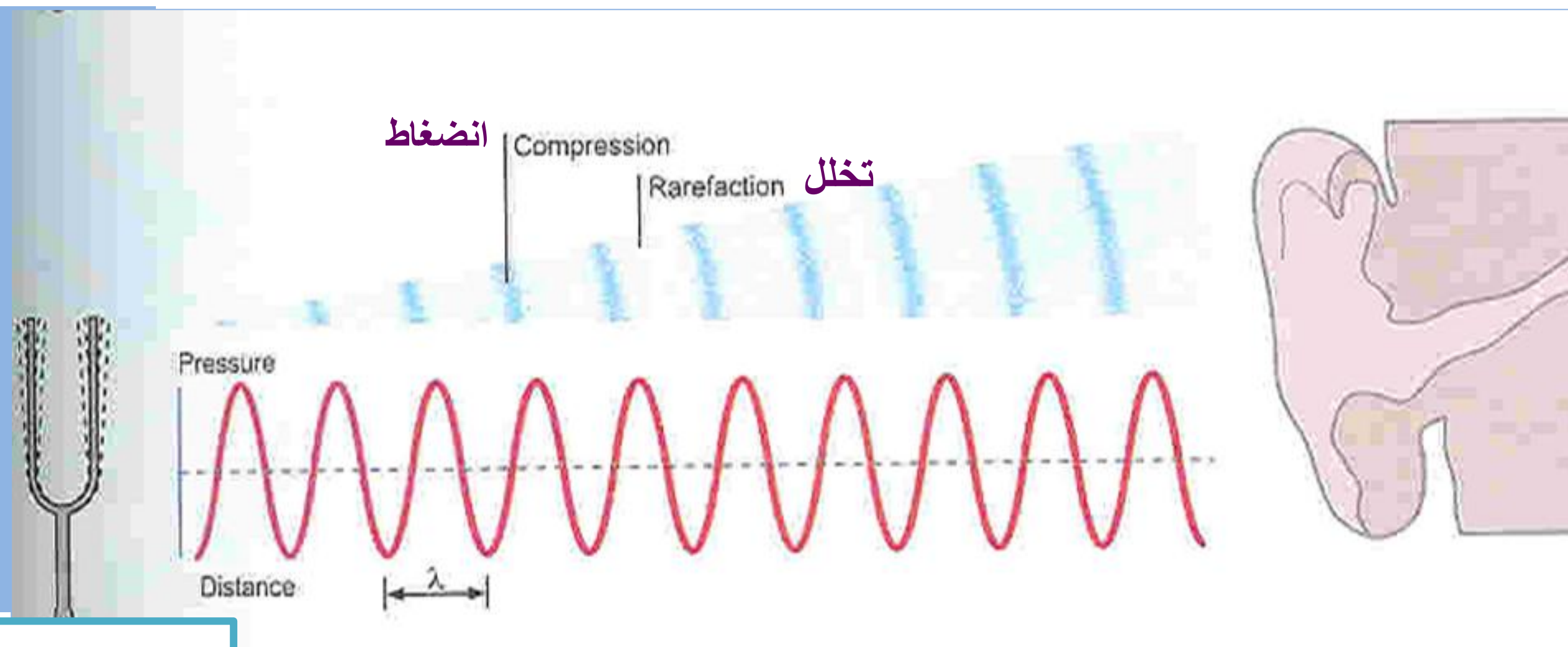
Function of outer hair cells
Large number, but stimulate only small fraction of nerve fibres in the cochlear nerve
If damaged, significant loss of hearing
(they control the sensitivity of inner hair cells to particular sound frequency)

Function of inner hair cells
Steriocilia not embedded in tectorial m. but bent by fluid movement under the tectorial m.
They are primary receptors for sound, transducing fluid movement in cochlea into action potential in the auditory nerve



Nature of Sound

Sound is produced from alternate compression and rarefaction of air molecules by vibrating body

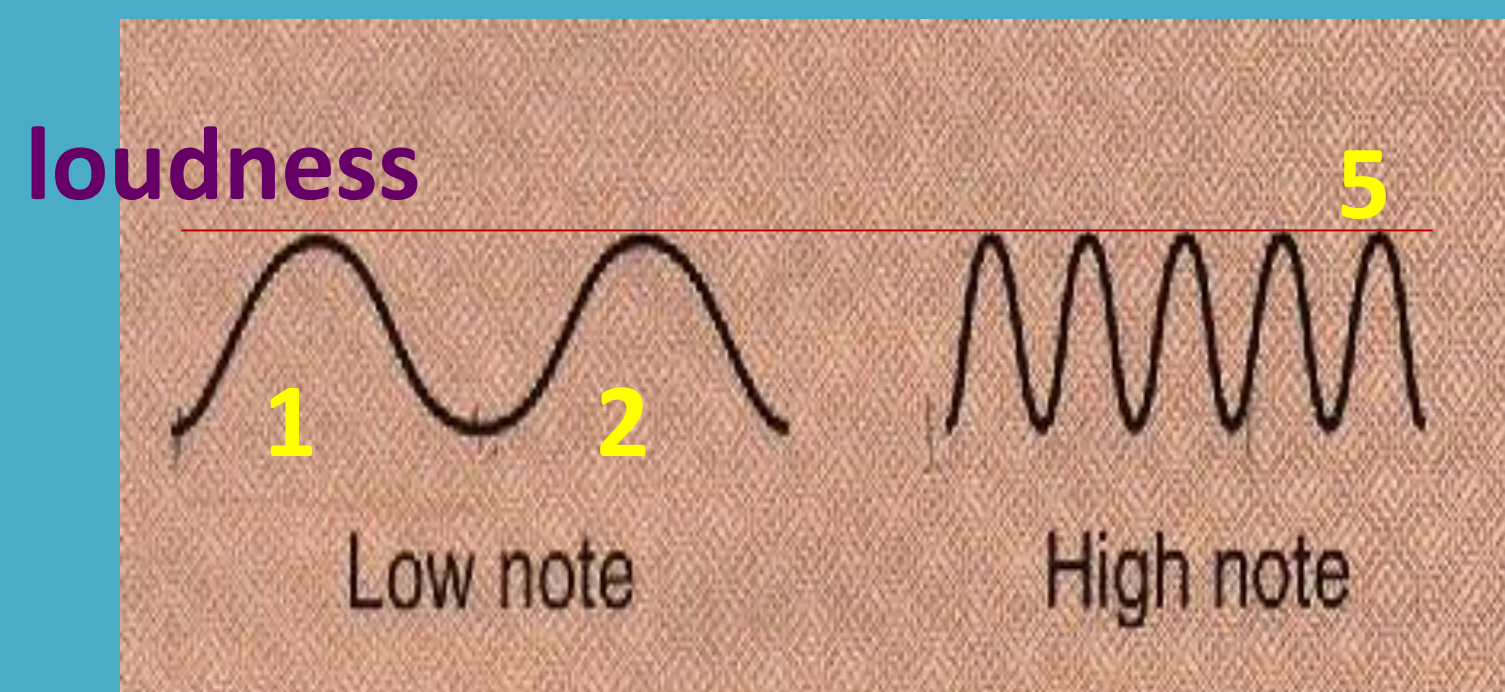


3 Characteristics of sound

1- Pitch (Tone) :

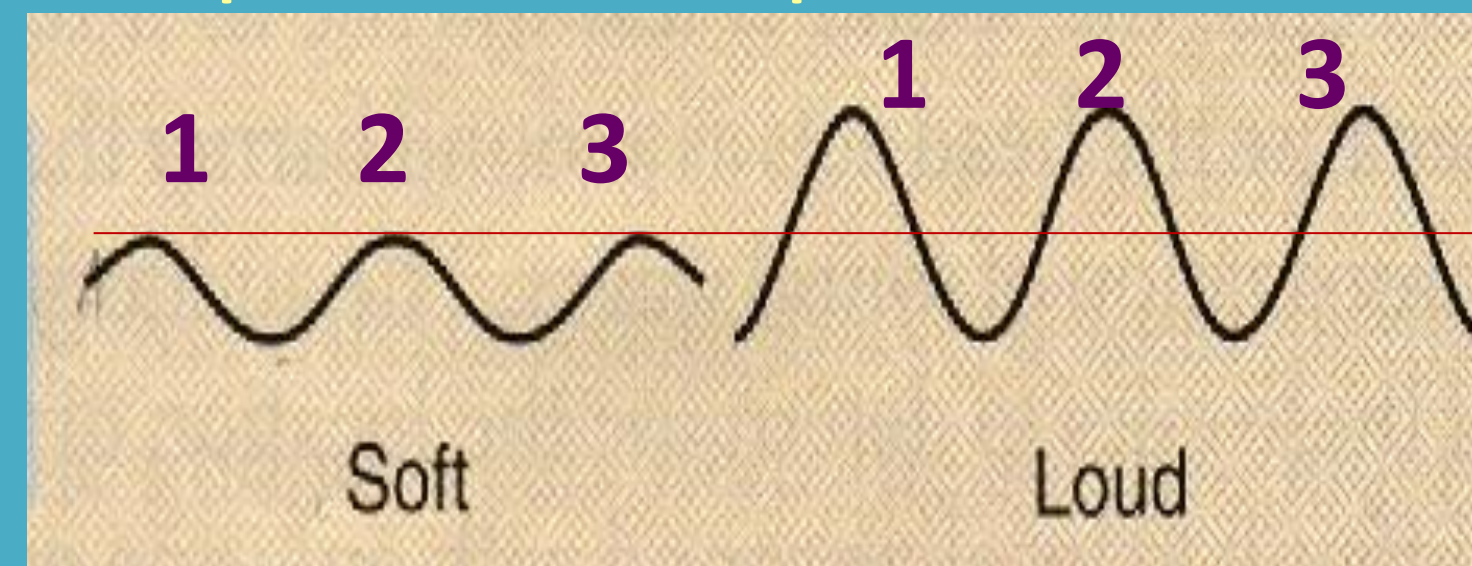
- depend on No. of cycle/sec.
- Human ear can detect sound waves with freq.. 20-20000 cycle /sec

Same loudness



2- Intensity (Loudness):

- depend on amplitude

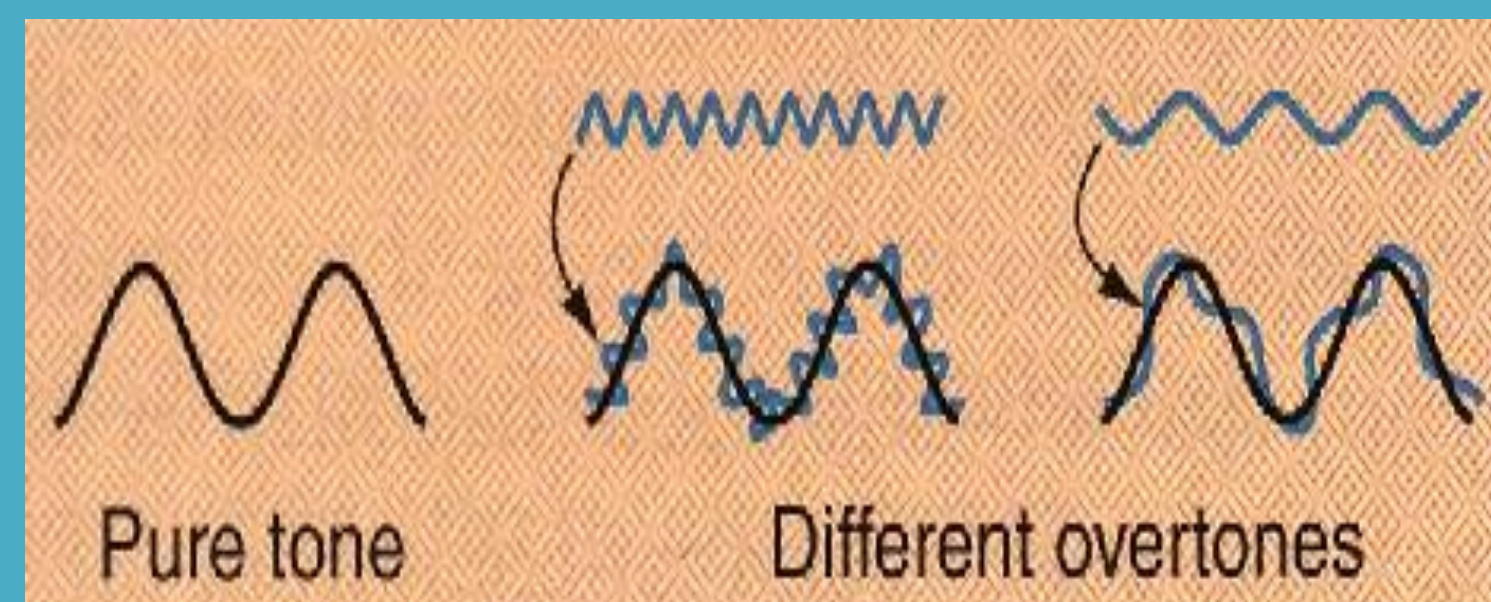


Same note

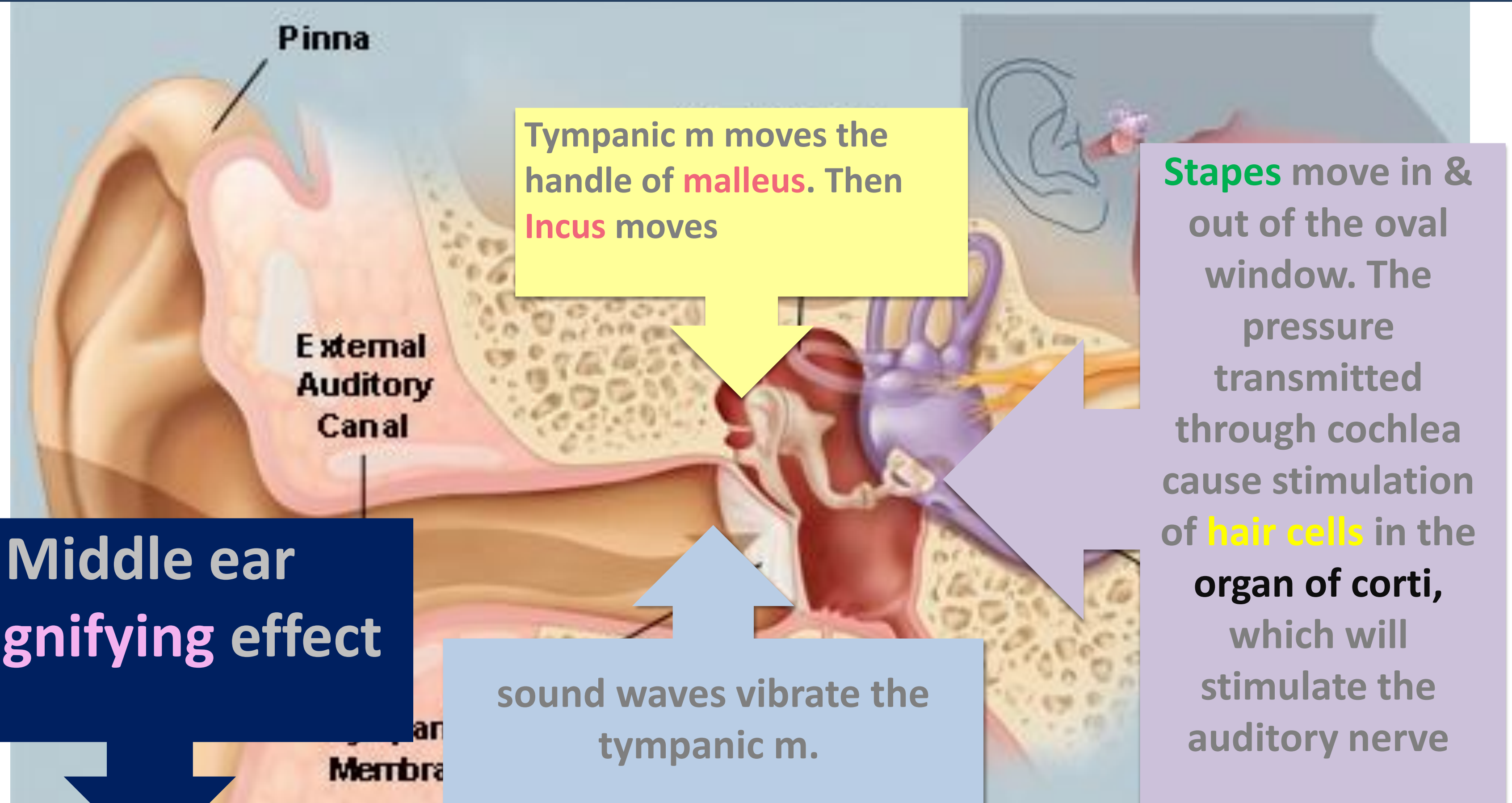
3- Quality:

- depend on the over tone or interference

Same note & loudness



Transmission of sound through the **middle ear**



The force from a large surface area (**Tympanic.M**) are concentrated to a small oval window the ratio is $17=1$ مره لان التمبانك كبير وهي اصغر 17 تتركز الاصوات ع الاوفل ويندو

Lever action of **ossicles** = the lever action of ossicles increase the force of movement 1.3 times نفس نظام عجلات الساعة لمن وحده تتحرك تحرك الثانية = ليفرأكشن

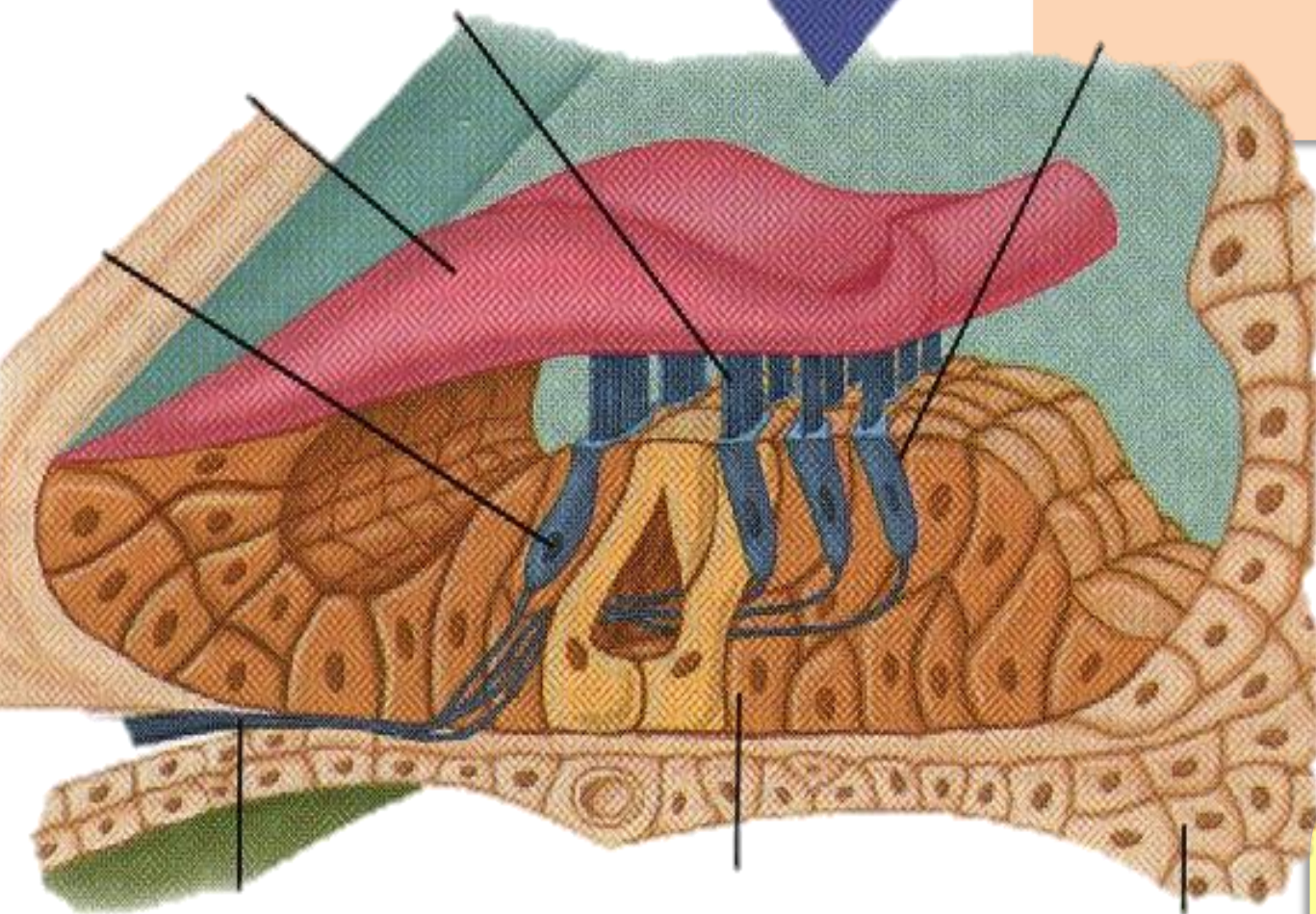
▲ the total increase $17 \times 1.3 = 22$ times

Receptors & Endocochlear potentials

Sound transmission into the inner ear cause upper & lower movements of the reticular m. (tectorial m.)

produce bending of steriocillia of the hair cells alternatively open & close cation channels at the tip of the stereocillia

» (inward current) **depolarization**
« (outward current) **hyperpolarisation**

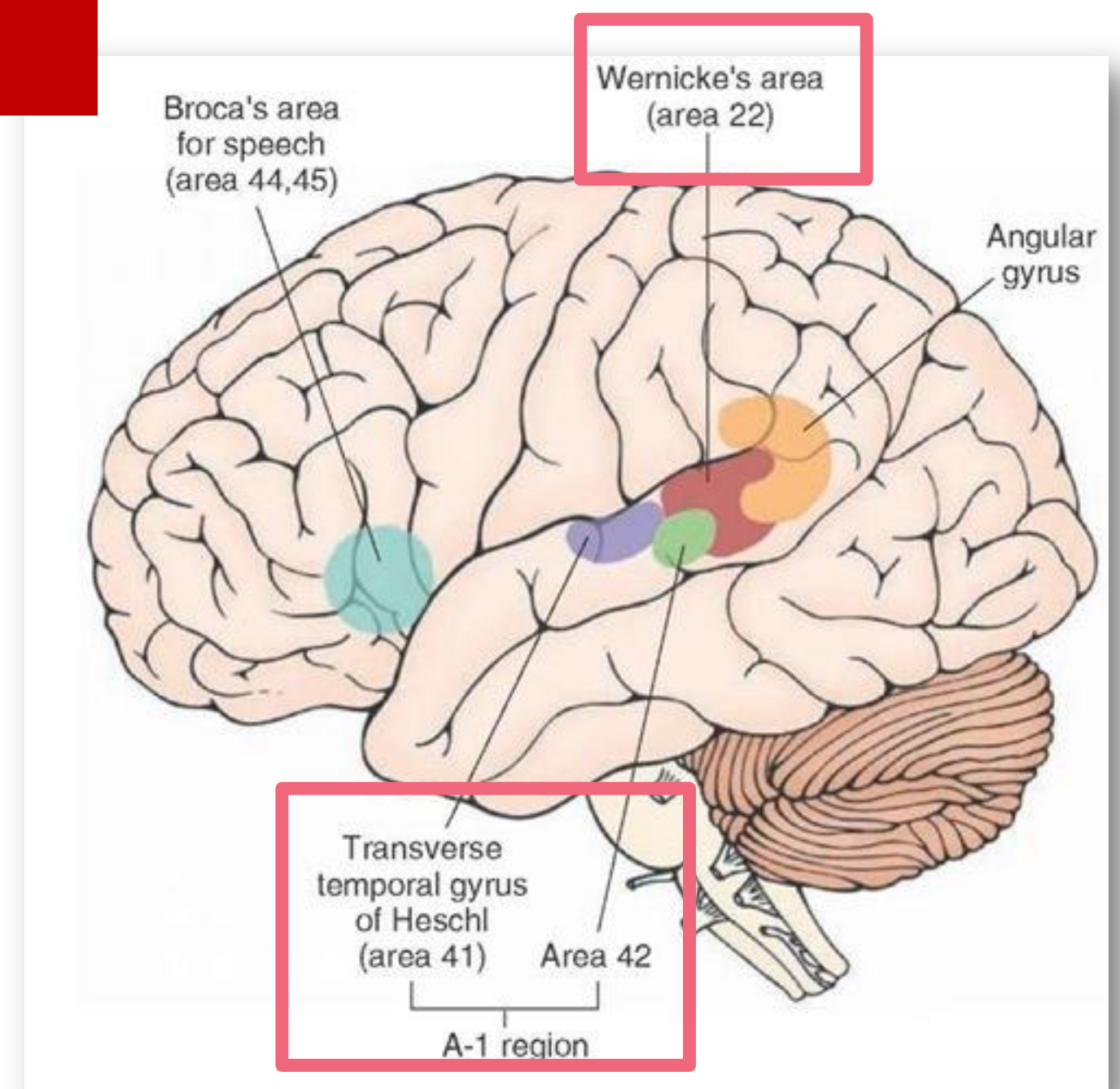
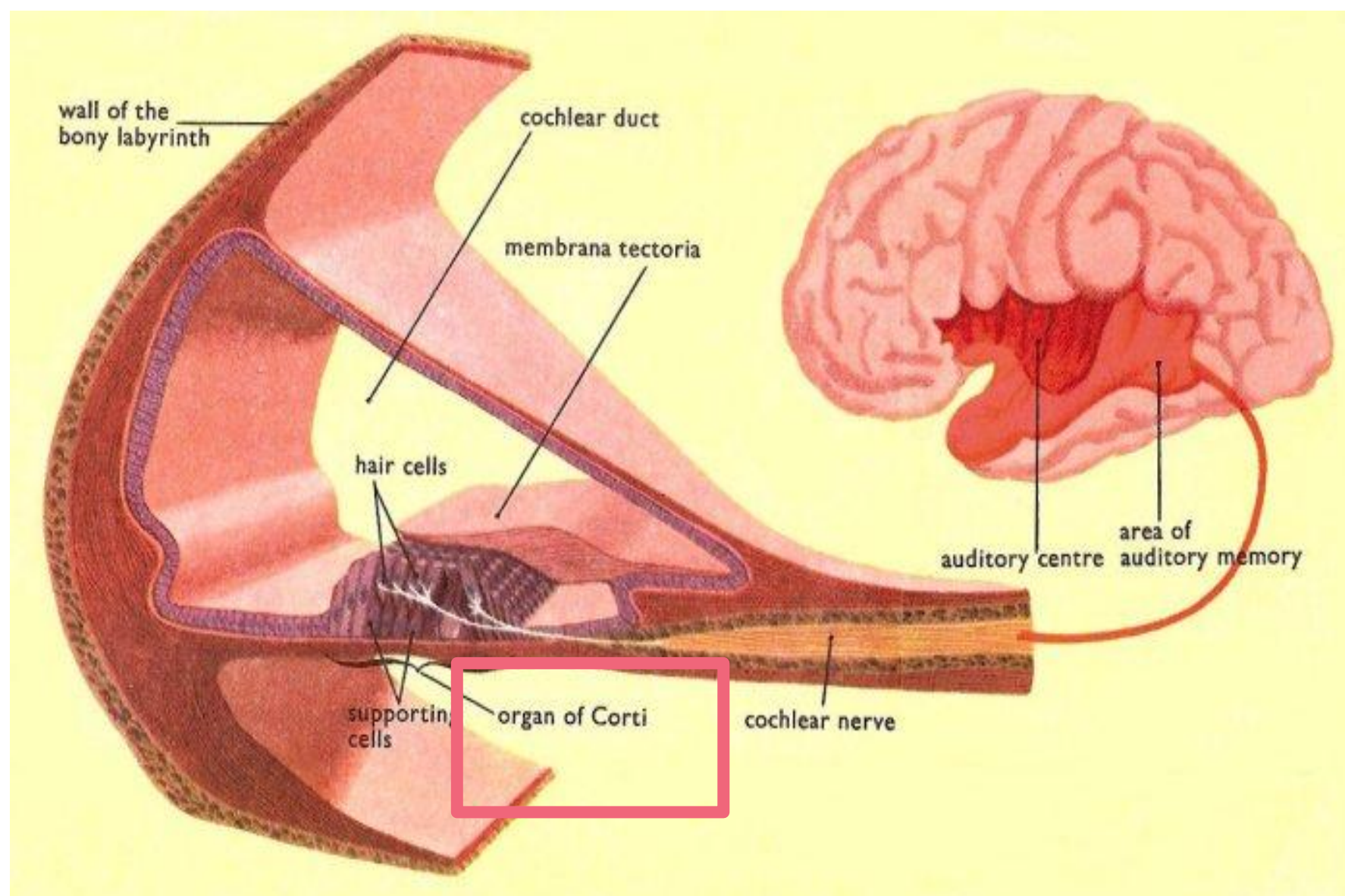


Production of cells receptors potentials :
»»»»» release of neurotransmitter
»»»»» production of action potentials

The Central Auditory pathway

This pathway begins in the **organ of corti**
End in the **primary auditory cortex** (are **41& 42**, superior temporal gyrus in the temporal lobe of the brain) مرحلة الاستماع للصوت هنا
Fibres end in the auditory area, where it is heard, then **interpretation** occurs in the auditory association areas
(**wernikes area**) مرحلة تفسير الأصوات تكون هنا

There is a **bilateral cortical** connection of auditory area
Thus damage to one side only slightly reduces hearing



Sound localization

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 (كان) مثل الطفل لمن يكون مشغول بالألعاب و ننادي عليه ما يستجيب الا بعد ما نغير طبقة الصوت

(حاصل له ماسك ايفكت)

Noise pollution is an environmental hazard

Exposure to sound intensity above 80dB may damage outer hair cells

Conduction of sound wave

- **Air conduction:**

Normal situation of hearing, sound travel in air causes vibration of Tympanic m., transmitted by ossicles to the oval window

- **Bone conduction:**

Sound cause vibration of skull bones directly transmitting the sound vibration to the **cochlea** (eg. when placing tuning fork on the head or mastoid process) لمن تسكر أذنيك وتسمع صوتك وانت تاكل او مثل المثال اللي في السلايدات التالي الخطوة الاولى

Deafness

Conductive deafness ايسال

- Impairment of sound transmission through external or middle ear due to:
 - Wax
 - Repeated infection
 - Perforated drum
 - Destruction of ossicles
 - Osteosclerosis (pathological fixation of stapes on the oval window)
- All sound frequencies are equally affected
- **Bone conduction is better than air conduction**

Perceptive deafness ادراك

- Due to congenital or damage to cochlea or auditory nerve pathway due to:
 - Toxins (antibiotics, gentamycine)
 - Inflammation
 - Vascular
 - Tumour
- **Both air and bone conduction are affected**

Test of hearing

- Audiometer
- Weber test
- Rinnes test

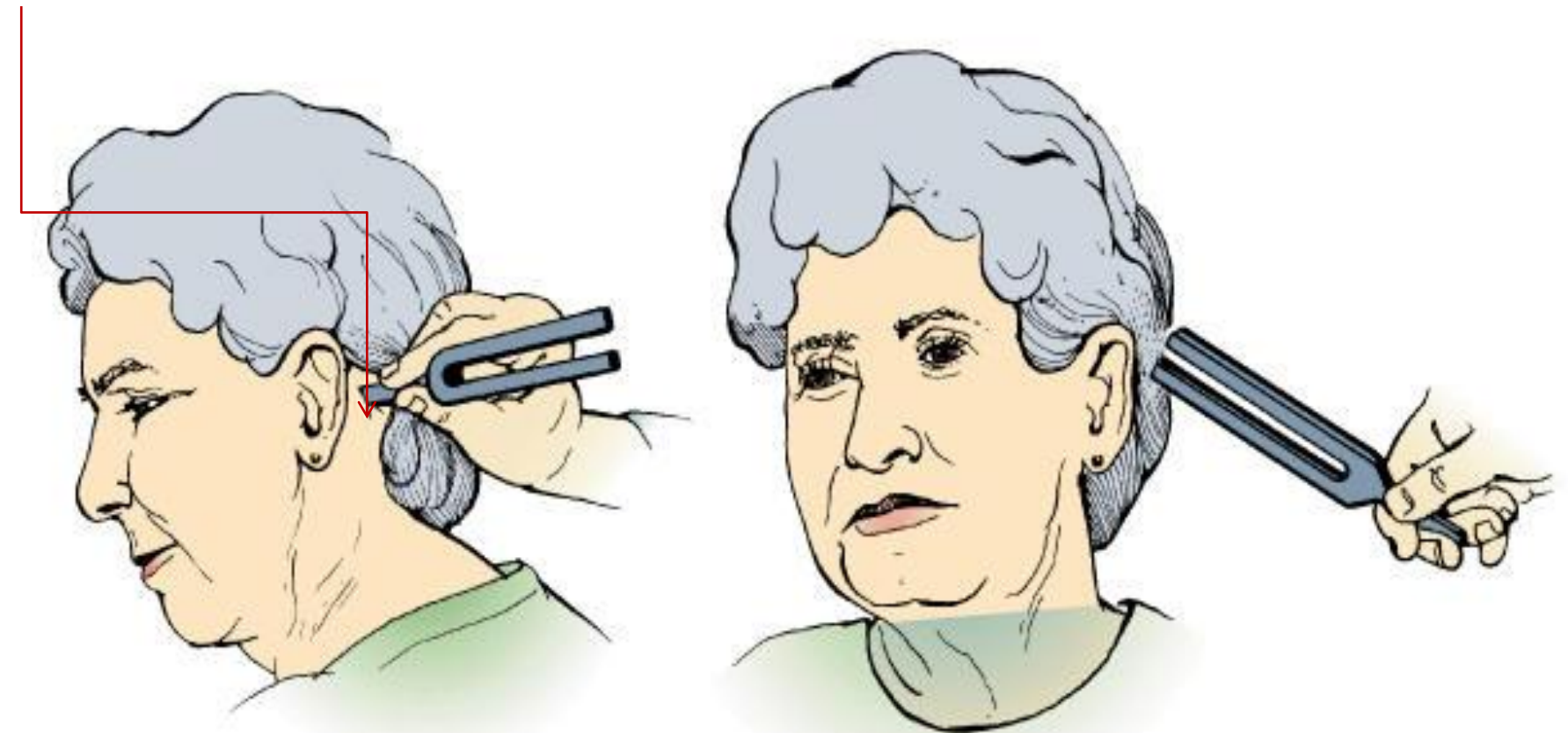
Rinnes test

1-The base of the tuning fork placed on mastoid process until the sound is not heard

2-Then the prongs of the fork held in air near the ear

Normal subject continue to hear near ear (**positive test**)

If not reverses the test (**if heard near the mastoid process, negative test**)



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CNS Block



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