The lecture is about the special sensation (Auditory ).

#slide 15 :

In the last lecture we took about the 2 pathway of the auditory :

1. Bioro pathway (the blue line in the slide) :Take the information from 2 ears .
2. monooro pathway ( the red line ): take the information from one ear or from one side mainly .
* We need the information to identify the place of sound and get the sound in 3D .
* So note that the blue pathway have a lot of overlapping and a lot of crossing of the information that come form 2 ears .
* I identify the **place** of sound For me by the **difference between the ears in terms of :**
1. Time .
2. Loudness .

That mean the sound that come from one side for example form right side >> I know that the sound come from the right because its arrive to right ear faster and its more higher in right ear than in the left ear .

\*So the bioro pathway Compare the sound In terms of **speed** and in terms of **intensity** .

\*In the cochlea the sound comes complex but we Analyzed it into different frequencies >> this is called
\*tonotopic organization : that’s mean every ton is organized on place in the basilar membrane ..

So the information when it go throw the first order neuron and reach the cochlear nucleus > every frequency will remain in the same neuron and line allotted.

\*\* so if I hear 2 sounds > each one has different frequency and each one come from different side > the region in the brain that compare the different in the intensity can compare the relation of different frequency .

Thats mean to know the place of sound we compare the time and the intensity .

**\***the part that compares the time isthe **medial part of superior olive.
(( superior olive is divided into 2 parts medial and lateral ))**

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| assume that I hear sound ,its frequency 1 kilohertz and it comes from the right side .. in the same time another sound comes from left side and its frequency 5 kilohertz , >> the superior olive must be compare that the 1 kilohertz come from right and the 5 kilohertz come from left side . |

\*\*So also in the superior olive each frequency is Separated from the other one ..

\*\*Quick Review:

The function of the medial side of superior olive is Determining the time difference > if I have 2 sound from different place and different frequency to identify it > I must separate the frequency … so every frequency must has its neuron and its pathway .

\*\*So if hear in the right side its ***faster*** in the right ear than in the left but be possible the different between it is 1,2,4,5 msec so to calculate the different in time it must calculate the different between it .. but we do ***NOT*** have Add and subtract in the neurons so for this we must have **line** for each difference .. that means I can NOT say the right sound is arrive to me in 5 msec and the left arrive in 7 msec >>so the different is 7-5=2 .

((So the neuron does NOT has the ability to do this calculation ))

to overcome this problem > the neuron put more than one line to every difference and ensures only one of them is work . Means it put line to 1 msec different, another line to 2 msec different and so on .. so when I hear sound if the difference is 2 msec the one that work just the line of 2 msec .> this the way to calculate the localization of time .

so in the medial part of superior olive , it has difference in time to every possibility of frequency differences and in the end for cretin frequency **only one** of these lines is work ,, that’s way to calculate the time different and we know we have different 2 sec to the right .

the difference in the time :

 so know ,, if I have sound higher In right side and the different is 2 msec ( arrive to right ear in 5 msec and to the left in 7 mse so the difference is 2 to the right ) , **BOTH**  superior olives are work but one of them will give me the time difference +2 msec (right) and the other will give -2 msec (left) .

Quick Review :

 I want to calculate the different between the sound that arrive > I hear sound on right side which need 5 msec to reache the right ear and 7 msec to reach the left ear so the superior olive on .right will calculate that the right is 2 more than the left , so its gave (+2) to the right ,so it will arise the line which has 2 msec which get the information to the brain and the other lines will be stop ... on the left side is lower than the right by 2 msec so it will arise

 (-2) to the brain .

\*\*So the 2 informations will help me to know from where the sound is come …

 The intensity :

he intensity is identify by the **lateral part of superior olive** to calculate it .. the ipsilateral side will give the excitation and the contralateral side will give the inhibition by interneuron **..,,that’s how we can calculate the intensity .**

the intensity is coded by amplitude and when its converted to neuron its coded by frequency or the speed of action potential if the right is higher because the sound from its side will give for example 120 action potential /sec and on the left side the sound will be less so the frequency of action potential is less for example 100 action potential / sec ,,so the ipsilteral side will rise 120 excitation to the neuron and contralateral side will rise to the neuron 100 inhibition so the difference will be 20 excitation ,.. so any neuron has base line activity and it will be increase by 20>> **but** on the other side we have ipsilateral which rise 100 excitation to the neuron and contralateral side will raise 120 inhibition to the neuron > so the difference is -20 inhibition .

\*\*(( the sound that has less time it will has more intensity )) .

\*\*One student ask about what is the inhibition ??

The doctor said to calculate the intensity we put one said inhibition and the other excitation and then calculate the different between it to know where it is higher .

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| The calculation of intensity is easier than the calculation of the time >>because the neuron has coding to it .. |

* We must have the monooro pathway because the bioro pathway has many overlapping and this cause loss of information ..

\*\*So the pathway is come from the first order neuron > to the cochlear nucleus >> to the superior olive ( superior olive manly identified the direction on horizontal plane) >> then to the lateral lemniscuses >> then to the **Inferior** colliculus (( the function of inferior colliculus is reflex and motor to the auditory. the function of Superior colliculus is reflex vision )) >> then to the thalamus >> then to the cortex >> then to the primary cortical area of the auditory on the inner surface of temporal loop …

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| The section in slides 17&19 is not include  |

\*\* pay attention every frequency separated on the basilar membrane it will continue separated on the cochlear nucleus ,and it still separated when I calculate the difference in frequency On the superior olive ,, also it separated on the thalamus to reach the cortex then in the cortex it still arrange in different frequency ..

* We took about the function of superior colliculus visual reflex or motor part of the visual the same in the inferior colliculus in auditory ,so when you hear sound and you turn your head to its said this is control by the inferior colliculus then from it >> its go to movement of the head and go to superior colliculus to move the eye.. These name **Acoustic startle reflex..**

\*\*We back to the hair cells ((slide 7)):

The hair cells are in the organ of Corti on the basilar membrane and its hair structure attachment to the tectorial membrane >> the cells that in the **front** are called **inner hair** **cell**s and the cells in the **back** called **outer hair cells** each three cell are in the same place .

The different between the outer and the inner are : we hear by the inner hair cells so because that every inner hair cell give one neuron or tow neuron (( because every frequency or tone needs its own representation on its line )) > so in sensory part from cochlear nerve will be get a lot from the inner hair cell ..

The outer hair cell send less of sensory but it’s not good and not defined . means every one neuron will take from 10 to 15 outer hair cells ..

\*\*\*But we have feedback to the hearing **mainly** go to **outer** **hair cells .**

What is the importance of feedback ??

1)When we go to the party the sound is high,but then we have **adaption** ( the adaption is happened by the **stapedius** **muscle** and **tensor timpani** ) ,,, when you in the party your friend want to say something to you ,in first time you cannot listen him/her y ..((the sound in the party is higher than his voice)) but in the second time you can hear what he say ☺ ..

2) when you stay in the ( 6ebyeh ) and it is Noise .. you hear your name then > suddenly you hear that sound even if there is anoise

How this is occur ??

By feedback loop which appears on **outer** **hair cells** ..

* The outer hair cell they work for Two reasons.
1. **Protection:** means on the high sound they help in prevent the movement or vibration of the tectorial membrane or basilar membrane..
2. They work as **selective amplifier**:

 in the party I don’t want to Cancel all adaption then I hear all the sound again, I want to hear the frequency of my friend and amplify this part and the others parts still adapted

 ( the order is come from the cortex to the outer hair cell to make amplification to this part of sound )..

(( **amplification** means increasing the sensitivity of this frequency )) .

\*\* the reflex of adaptation does not reach the cortex it reach the facial nerve on stapedius muscle..

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| \*\* the adaption of outer hair cell :in the reflex I want to cancel all sound and make adaption the first thing is the **reflex of stapedius muscle** to prevent the vibration but still there is a lot of vibration so I make the **outer** **hair cells stiff** so the tectorial membrane can not move easily against the inner hair cells . then I hear sound which I want >> in this time I have order from the cortex to the outer hair cells to amplify this signal . |

So the outer hair cells their contribution to the sensory hearing is not a lot.

Hearing problems can be measured by tow test :

1. Rinne test
2. Weber Test

\*\*we can hear the sound by **amplification through middle ear**

So the sound will entre through the ear but also it hits the bone and make vibration to the cochlea .

(( any vibration reach the cochlea>> make vibration to the fluid >> and make vibration to the basilar membrane))

But its **Easier** to hear the sound they come from the direct ear than that come from the bone ..Because we have amplification in the middle ear ,,,,,,so if I have vibration and their strength is 10 Newton and put it in the bone it can not make vibration in the fluid ,, but if we put it around the ear the middle are will amplify it to 100 Newton for example and can make vibration..

**\*\*\***So these 2 tests are depend on the **Principle that the hearing through the ear is Better than the hearing through the bone .**

* Rinne’s test : (slide 25)

Its depend on we get Tuning fork and hit it by something so it will make vibration and sound , then we put it in the bone of the patient Behind the ear,, in the beginning the vibration of the fork is high so the patient will be able to hear the sound through the bone >> then we say to the patient when you cannot hear anything tell me … so because its behind the ear he cannot hear the sound through the ear but he can hear it through the bone >> when the vibration of the fork become less the patient say I cannot here now ..

Then we put it Beside the ear of the patient now the vibration will be reach through the ear so he will become hear and we say when you cannot hear tell me .

On the normal person when we put it on their ear after he stop hearing on the bone >> he can hear the sound .

\*We have 2 situations of hearing problems :

1. We have problem in the conduction of sound from air sound to the cochlea ( sensory part ) > for example blocking in the ear wax or damage in tectorial membrane or damage in amplification part in the middle ear or infection .

In this situation the problem is the conduction of sound to (from outside to inside ). this is called :

**\*\*Conductive hearing loss** .

1. The second Situation is the **neuronal part** is damaged ,like inner hair cell death or inner hair cell damage or the nerve has trauma or damage or any damage in the pathway ..

The problem in the neural part and this called it

**\*Sensory neural hearing loss** .

\*\*So we have **two** possibilities for hearing loss :
**conductive and sensory**

if the problem of patient in **conductive hear** loss ,so we have blocking that prevents the vibration to reach the cochlea **in** **this situation the hearing** **through the bone is Better than the ear** so when I put it in the bone and I say when you stop hearing tell me >> when he said I cannot hear then I put it in the ear beside the ear he also say I cannot hear ..

\*\*So in this situation I know he has conductive loss .

In the sens**ory neural loss** everything is damage the bone and the ear,, so in this case >> when we removed from the bone and put it beside the ear he say I still hearing ..because everything is less … but in the end everything is less in the same level and still the **ear is better than the bone** ).

\*\*To differentiate between the normal people and the patients with sensory neural loss : in this case I supposed I’m normal and when he said I can hear the sound when it beside his ear and I still hear so he has a problem .

The second test which help me to know about the hearing problem or sensorineural loss is :

* Weber’s test:

 in the normal case , in the noisy room , if I have the Tuning fork and put it in the forehead or tip of the head so the vibration will travel through the bone to reach the cochlea > vibration occurs so I can hear …

\*\*in the normal person when the fork is raining of forehead the conduction through bone will be far and Weak because I have a noising>> which amplified so I hear the noise more than the fork vibration …

\*So if I have **conductive loss in the right side**
the fork on the forehead >> the vibration will go to the right and left side >> the **left** said which is normal has noising more than the vibration **so I hear the noising more than the vibration** …

\*But on the **right** side we have conductive loss I can hear the fork **vibration more than the noising** …so when you put the fork and ask :

\* The **normal person the 2 are the same** .

\* The patient with conductive loss he will heard the higher vibration of the fork **in the ear with conductive loss** .

\* But the patient with **sensory loss** ( if he has sensory loss in the right side he can hear the **noising more than the vibration** but less than the normal one so he will hear the vibration by the **normal ear** **better** **than the damage one** because in the sensory damage every things will be less ) …

\* All these tests are canceled because we have automated test!

Sorry for any mistakes but the lecture is very difficult .

 