>> October 19th, 2016. This is lecture 17. It's all about your sense of hearing. A very difficult lecture to deliver, because again, we're talking about something very tiny, something that's very complicated, and therefore lends itself more to handling models or detailed images than just talking about it. But we'll talk about it, nonetheless. The ear divisible anatomically into three regions or parts, that which we see as part of the external ear. That which is buried within the temporal bone is the middle ear and even the inner ear. So let's start with an image. Certainly this one is as good as they get. You have one in front of you. It demarks, and gives boundaries to these segments. The external ear is what we see and sometimes camouflage. Oh, no, the world's biggest ears. Oh, no. Everyone calls her Dumbo. How brutal. You think this might have been photo-shopped? I think so. Anyway, we often tend to decorate our ears. I'm always amazed at how people go wild in LA. They put these big things in there and they punch holes all over the place. And diamonds, rhinestones, all sorts of fun things, so it's really a nice little ornamental appendage there. But apart from that, this structure, which we call our ear is actually itself rather useless or almost, so it's called the oracle, also known as the pinna. The word "pinna," means wing, because it does look wing-like. A wing or a trumpet, and it's got a quite interesting design of course. But its main function is not to hear, but rather to concentrate, to funnel, to focus, sound waves into your external auditory meatus. In fact, if I put this up to my ear, I'm going to be able to hear you a whole lot better, because I have a bigger funnel, right. Maybe, you know, historically before hearing aids, something like this, a kind of megaphone was used to amplify and concentrate sound waves into the external auditory meatus. So not much more to say about the oracle. It's basically skin, cartilage, and fat. What's the cartilage?

>> Elastic.

>> Elastic cartilage. Now, once we move through the ear canal, we're entering into or shortly will be in the middle ear. Here's a look at the oracle, again, as everyone is familiar. And there's a device, there's an instrument that you had poked into your ear by professionals, I hope. It's called an otoscope. Never had your ears examined? And the person at the other end of that instrument is seeing this, which is at the end of your external auditory meatus, and I think everybody knows that's called the ear drum. It's actually the thinnest skin in your body, which is stretched across this opening, and is like the skin of a drum. In fact, the former or formal name for this structure is the tympanic membrane, aka, the ear drum. These plate glass windows could be like a tympanic membrane, and if someone were to drive through this driveway with one of those low rider Chevy's with the base up, what would happen to these windows?

>> Vibrate.

>> They start to vibrate, so the function of the tympanic membrane is to receive and vibrate in sympathy with the sound waves. It serves to catch and amplify sound, which is delivered to it through the external auditory meatus. The ear drum is the thinnest skin of the body, and as such is easily injured.

This is looking down the ear canal, and these are incidentally bristles of hair, which are equipped with sebaceous glands that produce a very different kind of sebum. This produces something called cerumen. What's the common name for that?

>> Earwax.

>> Earwax. And, of course, you might think that's just kind of, you know, yucky and unimportant, but earwax is very sticky, and it's designed to prevent insects, really, I think to take up residence in your external auditory meatus. You might think that's preposterous, but can insects find their way, and actually get going in here? Yeah. All sorts of fun stuff gets in the external auditory meatus. This is a view of the external auditory meatus. And this is not an insect. What's does it look like?

[Inaudible]

>> I'm sorry.

[Inaudible]

>> It's not actually a wax. This is a Qtip. And of course, well intended parents often put Qtips down their children's ears to clean out the earwax. This parent forgot that they left the Qtip in there. [laughs] So a trip to the ER. Now, this is what the otoscope would reveal, that is this is what the practitioner would see. This is the end of the external auditory meatus, and the membrane which we're looking through here is actually transparent, and the name of that is the tympanic membrane. On the other side of it are the three tiniest bones of your body. The malleus right here, the incas right here, and the stapes barely visible in this view. You've seen and memorize these bones. They're not in the external ear. They belong to the space known as the middle ear. So the tympanic membrane is in contact with and sets in motion these tiny bones called auditory ossicles. You recall their names. The first one is Malleus. That's attached to the incas, which then attaches to the final little bone called the stapes. And it's the stapes, which vibrates or moves rapidly in and out of another membrane covered opening, an opening into the cochlea, which we'll get to in a moment. An opening called the oval window, also called the cochlear window. Now, the eardrum, and for that matter, the ear canal is subject to trauma, and also subject to infection. This would be called an external ear infection, but by far the most common kind of infection is not external, but a middle ear infection. And so you know the name, the medical name for that is called otitis media. Otitis media. It is the most common reason that parents bring who into the doctor's office into the, well, their kids, because they have ear infections. An ear infection is common in kids for the following reasons. Notice that the middle ear appears to be ventilated or at least connected to the outside through something that I think most of you know is commonly called the Eustachian tube. Now, that's a proper name. It's an epinem, and it's named after somebody and it's Gabriela Estacio, I should say. And we're going to call it not the Eustachian tube, but the auditory tube, which is also a bit of

a misnomer, because it implies that it has something to do with hearing, which actually it does not. But the Eustachian tube is a pathway to the nasal pharynx and therefore to the outside world. It's cartilaginous, partly muscle, partly bone actually, and air passes through here that is from the nasal pharynx up to the middle ear. So it's not for hearing, but it is important and already known to you. What happens when you travel in mountainous terrains? What happens to the air pressure as you ascend?

[Inaudible]

>> Air pressure goes down, therefore the middle air, the air in your middle ear will now be in relatively high pressure, and that will push the tympanic membrane to the outside, making it tighter. Does that make it easier or harder for you to hear?

>> Harder.

>> And so you're hearing becomes muffled, doesn't it? So what's the strategy? What's the thing you do to restore your hearing?

>> Swallow.

>> Well, you may swallow, you may chew gum, you may pinch your nose and blow a little bit, although that's dangerous. What you're trying to do is bring outside air through your auditory tube to equalize air pressure on both sides of the tympanic membrane. And when that happens, your hearing is restored immediately, and you say, oh, my ears have popped, which of course they didn't really pop it all, but you did it equalized that air pressure. Now, with that said, this is the normal function of the auditory tube to equalize air pressure on both sides of the tympanic membrane, and therefore, to ventilate really the middle ear. But is the auditory to connected to a nasty place? What do I mean? The nasal pharynx. Is the nasal pharynx loaded with bacteria? You think? Nasal pharynx is your nose, more or less. Is your nose loaded with bacteria? All the time. And can these bacteria move up the auditory tube and enjoy a new location in your middle ear? And what's that going to be?

[Inaudible]

>> There it is, otitis media, an ear infection. Why is this common in youth, and not so much later? In children, this tube is shorter, straighter, and tends to be open more than closed. Yours is closed more than open, and the way you open your auditory tube is to yawn, swallow or move your jaw from side to side. So a middle ear infection, is bacteria moving from your nasal pharynx into your middle ear. And this can be very dangerous, painful and chronic. What does that mean? Chronic, long period of time. Some of you have children or maybe were a child at one point or another, and you had an ear infection. You may have actually had to have a plastic tube pass through your ear drum. This is the result of, again, a chronic ear infection, and this allows the pus and the pressure to drain. Anybody had that? Tubes in your ears? Did it help?

[Inaudible]

>> Okay. Well, sometimes it has to hurt to help. What are the options? Well, antibiotics are certainly no fun, and certainly at some point don't work. So this is called a [inaudible], and you can lead or should say, read more about it in your book. The auditory tube. Its function is to equalize air pressure on both sides of the tympanic membrane. Now, let's go to the inner ear, which of course is pretty well buried inside the temporal bone, and therefore it's pretty well protected. Oh, no, not this pesky battery thing again. I bet I don't have a charger here either. Well, you know, if I just ignore that, it's just going to go blank. So sorry. Be right back.

[Inaudible]

>> Okay. Thank you. That's going to make an interesting recording. You're going to hear me walking into my office and opening the door. And I'm sorry. All right then. So the inner ear is where actually the mechanoreceptors of hearing are located. And that space, which is carved out of the cancellous bone inside the temple bone is generically known as the labyrinth. A word which means a twisted tube. And the structure which is in there, is not a structure at all. It's two structures, which are mated and semi independent. So here we have a view of these two sense organs, and right away you should take a pencil, and make a diagonal line from this upper right corner down to this lower left corner, because that would essentially visually separate the two very distinct sense organs that are found in your inner ear. So that line, more or less represents the distinction. Everything above that line belongs to a complex structure known as the vestibular apparatus, also called the vestibular complex. Basically, this is filled with fluid, given the name endo lymph, which passes incidentally out and into the cochlear duct. Thus, the connection between the vestibular complex and what we'll mention in a moment is the cochlea itself. The vestibular complex features, nerves, sensory nerves, which are part of a two partner of the eighth cranial nerve. Remember the eighth cranial nerve? We gave it this name originally. We called it the vestibule cochlear nerve, and that's because it's really two nerves side by side, just like two fingers placed against each other. The vestibular nerve, alongside the cochlear nerve, and the two of them are called the vestibule cochlear nerve. Very distinct sensations travel through each of these independently. The vestibule, the word meaning, as you can see here, a kind of entry way. The vestibule is a fluid filled space consisting of two reservoirs called the utricle and the saccule. Please look for these in your textbook. And at the base of these structures there are receptors called maculae, which detect the physical orientation or position of the head. Sometimes these are called tilt receptors, almost like a spirit level. Ever seen a level that you use to mount a picture frame, that bubble? So if you move the level one way or another, the bubble is off center, something like that. These maculae, basically then detect the physical orientation, the attitude, the position of the head, whether it's on your shoulder, whether it's vertical, whether it's hyper extended, whatever the case may be. And this sense of head placement is called static equilibrium. The word "static" means still as in motionless. So if you are motionless in a dark room, and have no visual reference, are you

nevertheless aware of the position of your head, of course. And you can call that your sense of static equilibrium. It's also very interesting because it responds to vertical or linear acceleration. Vertical acceleration. And what's the most common scenario where you are vertically accelerated? Never mind Disneyland.

[Inaudible]

>> In an elevator, and in an elevator are you aware of your vertical motion without using the cues of the numbers? Of course. You can tell whether you're ascending or descending. And again, you can thank the vestibule for that particular function, something called static equilibrium. Now connected to the vestibule, but anchored at its own receptors called ampulla are three, three semicircular canals. Here's an enlarged model of what we're talking about. Semi circular means what it says. Half circles. And this is filled with the same fluid. What fluid? Well, actually endolymph, and these are oriented at right angles to each other, so that there's one in the sagittal plane, one in the frontal plane, one in the transverse plane. Now, let's go to an illustration that maybe captures at least the size of these things. I'm not going the right way. Going backwards. Why is that? All right. I give up. It's got a mind of its own now. Oh, there you go. Not sure how we got there, but now it's not coming through. It's a conspiracy today. [laughs] Conspiracy of electronics. It sounds like a Twilight Zone episode. Okay. I'll try this, which probably won't work. That should be the one that works. Got It. Got It. Obviously this is an enlargement, but taking our story back to the beginning, oracle, external auditory meatus, tympanic membrane, middle ear, Eustachian tube, and now the inner ear. The structures which are most attractive here are the semi-circular canals, oriented at right angles. And at their base. there's a little bulb or flask, which is called the ampulla. And inside of that we have hair cells, more or less grouped together like a paintbrush, which move in sympathy with the fluid which circulates through here. And this fluid will be disturbed, and set in motion as your body moves in any given plane or direction. This is what's called dynamic equilibrium. The word "dynamic," means to be in motion, so if you were locked in the back of somebody's trunk, you were being abducted. I'm making this a horrible story.

[Laughs]

Would you nevertheless be aware that you are moving along the street? Would you be able to tell that you have turned left, that you've turned right? And again, this is dynamic equilibrium. Something that we use and depend on all the time as we walk, because we're constantly sensing the terrain that we're walking, whether it's uneven, uphill, downhill, and so-forth. And so obviously and collectively, these two structures, the vestibule and the semicircular canals give us what is commonly called the b word. What?

>> Balance.

>> Sense of balance. And so disturbances of the vestibular complex, and/or of the vestibular nerve will lead to imbalance. It also leads to, in many cases

a sense of motion when there isn't any. And what's the name for that? It's a clinical medical term, starts with v.

>> Vertigo.

>> Vertigo. Vertigo is a sense of dizziness when, in fact, you're not moving or there's no sign of motion. So dynamic equilibrium, very important for maintaining posture, maintaining normal gait. And it works sometimes in sympathy, sometimes in conflict with visual information. Here's the scenario. You're in the backseat of a car studying anatomy, as you should be. [laughs] And somebody's driving through mountain terrain. Okay. Who's going to get carsick, the driver or you?

>> You.

>> You. Why not the driver? It's the same twist, the same terms, the same elevation, but you're in the backseat. You're not in charge. You're looking at your notes, and your eyes are telling you there is no movement, but your semicircular canals are telling you there's movement. And this is a conflict, which is disturbing, and creates, what's that called?

>> Car sickness.

>> Car sickness. But in general it's called?

>> Motion sickness.

>> Motion sickness. Can it happen on boats? Can it happen at Disneyland? Can it happen at any time? Yes. So this is a conflict between dynamic equilibrium, and visual cues. On a ship the best way to deal with this is to get up on deck, so you can see the horizon and reduce that conflict, because below deck your eyes are telling you there's no movement, but your vestibular complex is telling you there is movement. Question?

[Inaudible]

>> Yes. Oh, that's kind of the reverse. Your eyes are telling you there's movement, but your semicircular canals are saying, I don't feel any. So obviously the best, shall we say, virtual reality are those machines that gives you both. That is give you the sense of motion, and the visual cues. So you really feel like you're writing this device. I'm thinking of Disneyland again, where you're actually watching a movie, but your chairs are moving. So it's like, Ooh, this is the real deal. [laughs] Are there ways to fight or treat vertigo and motion sickness? Yes. But a lot of them are ineffective and preventive measures are better than corrective measures. So let's back up again. Here's a tight view of not the inner ear, but the middle ear. In case we didn't stress it enough, these bones don't just transmit movement, they amplify movement. So very weak movement of the diaphragm produces pretty big movements of the stapes. The function then of the ear ossicles is not just to transmit this movement, but to amplify the movement, which eventually will be brought to the stapes. Here's the inner ear. We've already dissected it, and we've talked about now the

vestibular complex. In the vestibular complex, we spoke of static equilibrium, which gives you your sense of head position, and we've talked about dynamic equilibrium which gives you your sense of motion. And certainly, even as a child you knew that this was somewhat annoying, because is it possible for you to spin around on a skateboard or something, and then stop and then what? You still feel what? You still feel motion. What we call dizziness is the fluid which is still moving through and disturbing the receptors in the semicircular canals. It's amazing to me that some people can overcome that with practice, and especially I'm thinking of ice skaters. You've ever seen that? They're going around 360 very fast, and then they just go, boom. And they're thinking, whoa, how can you do that? Practice. And as a final analysis, or I should say example, what about in space in weightless orbit around the earth? Gravity is not on the table. Right? And so do astronauts, cosmonauts get motion sickness. You Bet. Big Time. And vomiting in that environment is not particularly welcome. [laughs] Well, it's never welcome. It's always a mess to clean up, but especially when vomit's going everywhere. You know. Bad example. [laughs] All right. The cochlea. The word cochlea means snail, S-N-A-I-L, because it resembles a snail's shell. Actually about two and a half turns, which is an interesting question in itself, why this coiled arrangement? It's not a hard question to answer, because I imagine you may own or have a sleeping bag at home, just guessing and you just throw it in the closet. No. What do you do with it?

>> Roll it.

>> You roll it up. To save what?

>> Space.

>> Space. Same thing here. It's a space saving mechanism. The entire cochlea, if we stretch it out, would be less than an inch long, and when we roll it up, it's about the size of a pea, P-E-A. lt contains three parallel tubes, which we're about to dissect. And, in fact, here's the cochlea, two and a half revolutions, just as we said. Essentially, these parallel tubes are separate, but interconnected functionally. Here's a slice through the cochlea, and just to stress there are three parallel tubes. So that one, that one, and that one, or if you like, that one, that one and that one. This is also a section through the cochlea, and you can see three parallel chambers there. These are called scala. The word scala means staircase, which is actually a reference to music or sound, but like it or not, that's what they're called. These scala are continuous with each other, at least the scala vestibuli, and the scala tympani. So what I've done here on the board is what you should practice at some point, and you have one already built for you at the bottom of page 69. An unfolded, an uncoiled cochlea. You recognize this bone or should. This is the last of the ear ossicles. That's the stapes. And it's resting in a membrane covered opening called the oval window, as we said a moment ago. Membrane covered, just like this screen. It's what? It's flexible. So when the stapes pushes against that membrane, does the membrane yield or otherwise respond? Yes. Beyond that opening, which is called the oval window, is this passage way, which is referred to as the scala vestibuli. Notice as we follow

it to its conclusion, it actually folds back on itself and changes names. So on the return path that same tube is now called the scala tympani. Both containing a fluid, a fluid known as perilymph. At the end of this scala tympani, there's another window, another membrane covered opening, which is basically round in appearance. So deserves the name round window. To repeat, the proximal end is called the oval window. The distal end is called the round window. What fills both of these scala? Perilymph. So you have to think mechanically now. The movement of the stape will cause vibration of this membrane, and set up fluid movement. That is it will create pressure waves in this fluid. What's the fluid?

>> Perilymph.

>> Which then will move down to the tip and then back along this lower scala, which is called the scala tympani. Those fluid pulses will be dampened by the movement of this membrane. When I say "dampened," that means those shockwaves will be absorbed by the corresponding movement of this membrane. And this is very important, because as these fluid waves go down, and then back along here, would you want them to strike something rigid, and then return from where they came? That would collide with incoming information, and there would be conflict and canceling, so in short, the function of the round window is too absorb the shockwave, which is coming in that direction through the perilymph along the scala tympani. And it's very important at this point to stress that there is no sound whatsoever in any of this discussion. Where has sound, as we know it been left? Yes, sound came into your ear. Yes, it went down to the auditory too, but where was that sound actually left? Right at the tympanic membrane? The rest of this is silent movement of these things. What things? The tympanic membrane, the malleus, the incas, and stapes. All of this is completely silent, but nevertheless represents mechanical distortion of this fluid, which has traveled first through the what? Scala vestibuli, and then down along back through the scala tympani. So the function of these scala is to conduct, that means carry fluid pulsations, not sound from the oval window to the end of the round window. So far this has done nothing but just that. Here's another sketch of what we're trying to do, and what you should practice yourself with pencil and paper. Now the third of these tubes is situated between the scala vestibuli and scala tympani. And this is actually filled with endolymph being connected to the vestibular apparatus. So the fluid here's a little different, but the smallest of these passages is known as the scala median, aka, the cochlear duct, which houses what's called the spiral organ. So this is a nice view, an artist's concept, again, of these three parallel tubes. This one above, we already gave name to. That one there, scala vestibuli. This one down here is the scala tympani. Are they connected? Yes. So that if pressure waves are going down here, they're going to be coming out here. Notice that there is a membrane, a partition, a divider, which separates the scala media from the scala, what's this down here?

>> Tympani.

>> Tympani. And the name of this membrane is the basilar membrane. Coming from a word base. Now this image is not an artist's concept. This is the real deal. So you see the three tubes here. This is the scala vestibuli. Down here? Scala tympani. This is the cochlear duct, also known as the scala media. Media meaning in the middle. Are these filled with the same fluid? Nope. Peri [inaudible] fills this and this, endolymph found here. The structure which is throughout the length of the scala media, and shown nicely here, and is in its entirety referred to as the organ of corti, also known simply as the spiral organ, because it is in three dimensions spiraled up. The cells that are critical here are called simply hair cells, because they contain projections, short little cilia, which made contact, which actually are embedded in this overhanging membrane. What's the name of this membrane that sits on top of these hair cells? It's the tectorial membrane. The word tectorial means roof, R double O-F, because it is a kind of roof overhead. This membrane, the tectorial membrane is relatively rigid and fixed. The basilar membrane is anything but, because the basilar membrane is in contact with the perilymph, which is obviously experiencing pressure waves passing down and along it on the way to the oval window. So I suppose there are better analogies, but let's say this floor is the basilar membrane. Is it rising and falling? Yes, it is. And then I'll be the hair cell. I don't have any hairs, but just pretend. And this overhead here is going to be what?

[Inaudible]

>> Tectorial memory. This doesn't move. Does the floor move? Yes. Am I going up and down? Yes. Are my hair cells being bent as a result of contact with the overhanging tectorial membrane? Yes. And these are [inaudible] receptors. That is those hair cells when they're bent, are going to produce a chemo electric change in these cells, which then converts that mechanical energy into electrical energy, which has carried out the cochlea through the sensory nerve with that name. What is the sensory nerve which exits the cochlea called? The cochlear nerve. And it blends with the one coming from the vestibule. That one's called the?

[Inaudible]

>> And the two of them together, the eighth cranial nerve, the vestibular cochlear nerve. Now at this point, let's be clear, the cochlear nerve carries information about sound and only sound. The vestibular nerve carries information about movement, whether head or whole body movement. So the spiral organ is shown here, and you should be able to sketch it. It doesn't have to be pretty, but it should be accurate. It should show the basilar membrane, the hair cells, and the overhanging tectorial membrane. This is an actual photo of exactly that, and this is an enlarged version thereof. So without labels, what's this?

>> Basilar.

>> Basilar membrane? What's that?

[Inaudible]

>> And what are these cells called?

[Inaudible]

>> That's it. What's the fluid that occupies and fills this space called the scala medium?

[Inaudible]

>> Endolymph. What fluid is found here in the scala tympani?

>> Perilymph.

>> Perilymph. Which membrane moves, the tectorial or the basilar?

>> The basilar.

>> And that disturbs the hair cells, which then trigger a response, and therefore eventually, eventually convert it into a sense of sound? By what portion of your brain? What portion of your brain makes that final conversion from electrical signals to what you're hearing right now? My voice?

[Inaudible]

>> No, it's not Brokaw's area. It's the lateral portion of the temporal, the so called auditory area of the temporal lobe. Right. So just as with vision, can you be deaf because of a brain injury to the temporal lobe? Yes. Can you be deaf because you have an injury to the cochlear nerve, or to the cochlea, or to the ear ossicles, or to the tympanic membrane, or just because you got wax in your ear? Yeah. All of those things will cause some degree of hearing loss. Now, these hair cells are critical. They are only about 20,000, and they're scattered along the length of the scala medium. These are [inaudible] receptors responding to movement, and without them you'd be totally deaf. Indeed, there are people that are born with their cochlea, born with everything except the what? Except what?

[Inaudible]

>> And so they are from birth, what?

>> Deaf.

>> Deaf. Totally deaf, and then there are those that abuse their hair cells, and who are those?

[Inaudible]

>> Yeah. They were there, I was at a concert, man. And somebody put me right in the front row. I mean, I'm not kidding you. It was overwhelmingly loud, and so, and I didn't come with earplugs, so I have on my phone, maybe you can get this. You can get this app. It's called a db meter. It actually reads sound and it was, it was off the chart. It was in the red areas, like leave now immediately. [laughs] That's what it said there. Now, I was trapped. Now, I'm only half joking, because are loud sounds permanently injurious to your

hearing? Yeah. And what sort of professions obviously then should be aware and take preventive measurements?

>> Airplanes.

>> Yeah. People working around jet engines or aircraft of any kind. People working in gun ranges. Certainly a Mick Jagger should be totally deaf by now. I'm not sure why it's not. Maybe he is. But anyway, hair cells. You can't replace them, and therefore you can protect them. Now, you might say, well, I'll just get a hearing aid. Well, a hearing aid is really a primitive device. All it is, is a little amplifier in your ear canal, and basically it's shouting into your ear, which is not going to help if you don't have any hair cells. What if you're born without hair cells? Well, maybe you know there's a sort of work around called a cochlear implant. This is actually just that. An electronic implant which is threaded through and into the scala tympani, and essentially takes the place of these hair cells, and stimulates the cochlear nerve creating an impression of sound. It's not very precise. Here's the outer appliance, which is the cochlear implant. Ever seen anybody with a cochlear implant? Did you know that person?

>> Yes.

[Inaudible]

>> Is he happy with the surgery and [inaudible]? Because it does restore some sense of sound, but I'm quite sure it is not certainly anywhere near perfect, and therefore the ability to decipher words.

>> And he before he got that he learned how to sign language, so he can also proofread [inaudible].

>> And you may be aware that in the deaf community this device is very controversial. Why? He might think, why would someone who is deaf not want a cochlear implant? Wouldn't they want to hear? Well, actually not. Why not? They feel, you know, hey, there's nothing with me. Don't try to fix me. I'm perfectly happy. Leave me alone. And I respect that, because who are we to say that you must hear, especially if you're doing quite well with what? Sign language, and so forth. So it's controversial and certainly not intended for or even welcomed by many people in the deaf community. So to repeat and finish, the spiral organ extends down the length of the scala media. It's here where we find these hair cells matted on the basilar membrane. And then the movement of the basilar membrane disturbs these hair cells that is, pushes them against the overhanging tectorial membrane, and this stimulates and sets up electric signals, which exit through the cochlear nerve, eventually making their way to the temporal lobe of the brain. So, remember, it's not sound, it's just electrical signals. It's not actually noise of any kind until it reaches the brain. Look for that video, and practice, practice making your own sketches, which might be better than mine.