Animal Physiology
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Lecture – 40
Olfaction System

Welcome back to the lecture series in animal physiology. So, we are into the fifth lecture of the 8th week. Last lecture we talked about hearing, and we talked about the ear cells present in the ear. And today we will be talking about to olfaction, but before get into olfaction in the field of prosthesis there is something to do with hearing and I which I wish to share with you. If say for example, all your ear cells in the ear or in the cochlea goes off or the auditory nerve is not functional.

So, there is a way you can hear it you can interface your auditory cortex or part of the auditory nerve carrying signals from the ear to the auditory cortex with a prosthesis device, which is a mic. And by such an interfacing or such a neuro electrical interfacing or hybrid interfacing, one can hear. And in the history of prosthesis the first very successful prosthesis were hearing prosthetic aid, where people or the scientist interface the auditory nerves with a artificial hearing system which is a mic through the electrode contact. And it was an 8 electrode configuration. So, in a way it was something like your, I told you that these are the frequency coding which are taking place.

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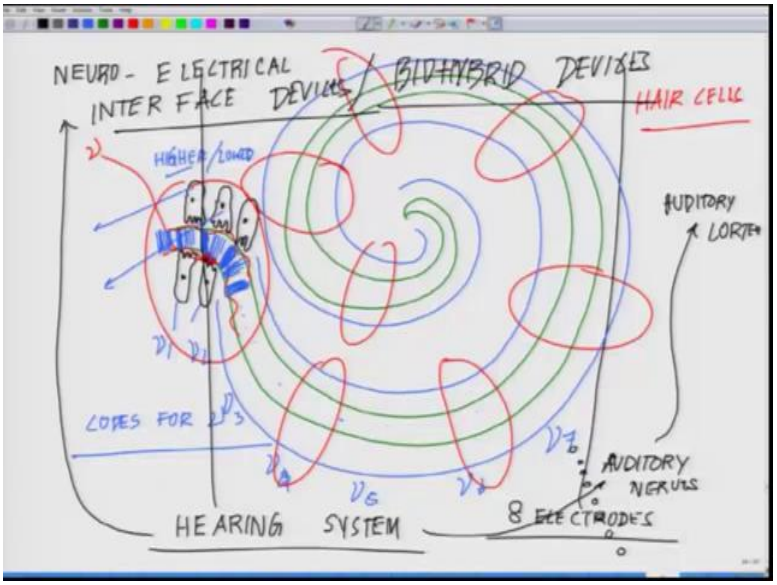

So for example, this whole setup is not really working the way it is, what you can do essentially, you have a hearing system which is a electronic system which is interfaced with auditory nerves assuming the part of the auditory nerves or functioning and that will be interfaced with auditory cortex of the brain. And most of these the very first one were 8 electrode devices for hearing.

So, in the history of hearing or in the history of prosthesis this was until this date is a landmark discovery or landmark engineering model, where you can bypass the sensory system and interface a gadget or a electronics to the brain. And which give birth to the whole paradigm or a concept of neuro electrical interface devices or also called biohybrid devices, which is a very interesting area, where lot of electrical engineers, lot of biologist, lot of material scientist, lot of electronics people lot of digital signal processing people are engaged to develop more and more prosthetic systems. And a similar system while we will be talking about vision we will talk about the cameras which could be implanted if your retina is not working fine. But at this point just keep this in mind which I kind of you know missed out in the class.

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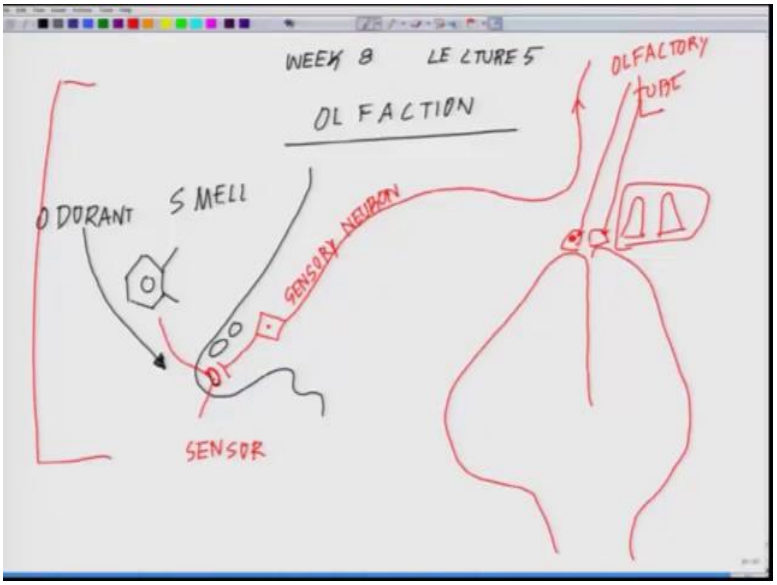

So, coming back so, today's class which is week 8 lecture 5. We will talk about olfaction. Olfaction or smell, and in human being this smelling parameter is not that evolved currently because we being more dependent on vision do not really use this smell modality for our survival instinct. We do use it, but not that much. So but let us see

how it looks like and this is very, very well developed in dogs, rats, insects and we will take few examples how those could be utilized.

So, say for example, there is an odorant molecule. Say for example, you use the perfume. So, some say aromatic aroma I am putting aromatic compound because the name aromatic compounds came because they have a smell. So, some kind of say aromatic compound which is present there which is coming and binding to it is receptors which are present here the specific receptors where this aromatic compound comes and binds.

So, this is the sensor system in your nose. Now from here the signal will be ferried through a sensory neuron or through an olfactory neuron through spinal cord to the brain, maybe it may bifurcate into 2 different neurons. So, this is your sensory neuron picking up the signal. Now this will go to the olfactory lobe. In human this is not that well developed, it is something like if you see I have the brain pictures like this spinal cord here. So, the olfactory lobes area here, these are the olfactory lobes. In if you look at it in rats or other things these are fairly huge and very well developed. So, this info comes to the olfactory lobes. In the olfactory lobe the processing occurs and we come to know what is this odorant all about.

So, this is the basic circuit and depending on how evolve the species yet it can distinguish x number of odorant molecules. But this odorant business could be utilized for some of the applications in our day to day life. And that what we will be talking about today. But this is the basic circuit what I talked about.

In our day to day life there is you have seen something called you know we use some kind of a lotion or something which repels the insects insect repellent or some kind of when we go on tracking we put some kind of a lotion what are these really.

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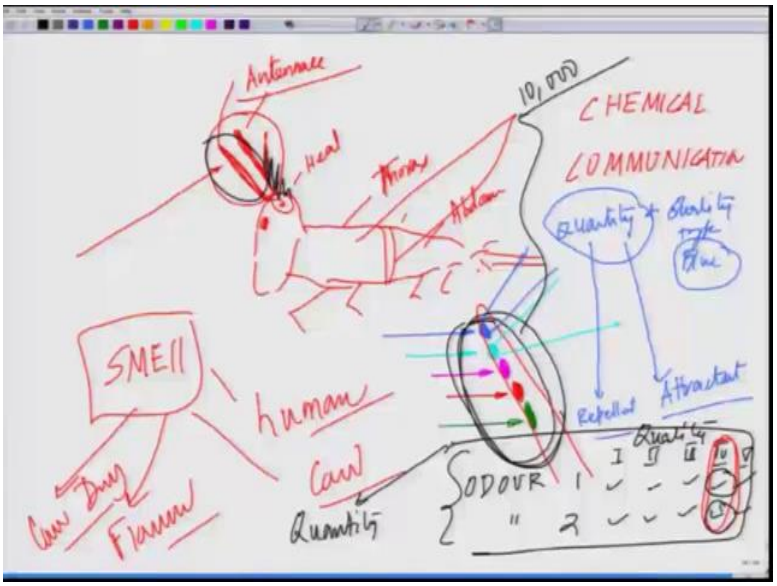

So, if we look at an insect they have these wonderful antenna sitting there. And they have a 3 segmented 3 layer body something like this head, abdomen sorry, head thorax and abdomen, something like this, and the wings.

So, these are the antenna or you can call them the nose of the insect. So, the odorant molecule binds here this sensor signal to their brain. Now say for example, you wanted to repel an insect, what will you do? So, I give you a mixture. So, say for example, this look at the other way, you might have seen there are insects which get attracted towards certain kind of dour. Say for example, you must have seen cow dung lying down; you see lot of insect in and around. You will see the insect kind of you know hovering or the mosquitoes hovering around part of your this part of the body, like you know under arms, and all these places why is so? What makes them, they do not identify by your name right? How do they identify? How they communicate with each other? They communicate something called chemical communication, what does that mean? Chemical communication means they identify their target based on smell, they know that this is human smell, this is cow or buffalo whatever, or this is a flower smell, or this is some say cow dung or whatever ok.

So, there are different kind of smells. So, these process these antenna one point. So, they have say for example, multiple receptors and I am showing the receptors in different colors. For simplicity sake we concentrate with 5 different colors assuming their 5

different possibilities which are there, 5 different molecules can bind, but how we could create combinations out of it.

Now, suppose there are 5 different odorant molecules which can bound, and name them as blue, green, red, pink and light blue. Now each one of them are function of quantity and quality or type or type. So, in this case type is already defined that is blue right. So, blue type it could be anything it could move x y z aromatic molecule. But the quantity this is very important to understand. Why it is very important? Say for example, all of us use perfume allow us uses deodorant. If you use excess you just feel you know very uneasy at times. Or suppose you are in a party and somebody passes by having a very thick deodorant smell, or a very thick perfume smell, you just get kind of some of us kind of get like you know, man that is too much. So, it means whereas, the same perfume or a deodorant at are lesser concentration may be very soothing. So, that is what it meant by quantitative computation. So, the quantity of that particular odorant binding decides whether this will act as a repellent or as an attractant.

So, in other word there is nothing called in the known literature of smell, there is nothing called absolute repellent or absolute attractant, it is always somewhere in between. There is absolutely nothing absolute about this whole thing. This is the first take home message what I wanted to give you, that there is nothing called absolute.

Now, having said this. Say for example, at one point you get a combination of all the 5 say for example, a odour is a mix of all the five, but now how you can distinguish that if another odour comes, say odour 1 having all the 5 element dark blue, light blue, pink red, green. Odour 2 again all the 5 element; 1 sorry, 1 2 3 4 5 this one also have, but then how you could distinguish between odour 1 and odour 2? You can distinguish odour 1 and odour 2 depending on if this is the quality it is telling that they have this type, what is the quantity? Because varying any of these quantity say for example, I vary the fourth one say the red one. The whole complexion is going to change because the signal what will be propagated from here to the brain will be different, then if this red one is more here oared one is less here, apart from here we are considering all the 5 components are there.

So, imagine if this total number of this becomes say you know I can identify say 10 thousand individual molecule, what all possible combinations one can do? The combination can be unfathomable, that is how far one can do. And as a matter of fact the

whole world perfume industry, France, India, some of the rich places, specially very close to IIT Kanpur there is a place called Kanauji, which is famous for exporting the best quality of perfume all over the world. This whole industry on this olfactory physiology, what do you smell, I mean what kind of a smell.

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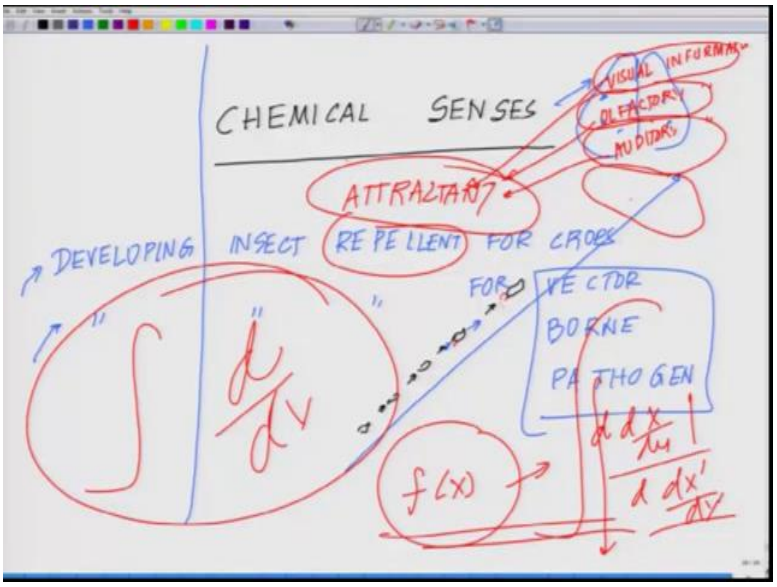

So, essentially it all boils down into, the word what I mentions chemical communication and chemical senses. And in the same line you must have seen the small ants following each other like this. This is also that chemical sciences or chemical communication, where each one of these the one which is head of the other secrete certain chemical which is being responded by the second one this one secretes something which is responded by the third one likewise and they move in a train like this.

These are some of the very interesting areas which covers from human physiology to insect physiology, and they have few others very commercial agricultural applications. The commercial agricultural applications includes developing insect repellent for crops, because you are using the basic physiology, insect repellent for crops. Or developing insect repellent for vector borne pathogen. So, vector borne pathogen are something like malaria where the in insect is carrying the pathogen. And if you have a way you can repel that vector you can you know prevent that disease to occurring particular area.

First of all of course, you have to prevent their breeding and you have to ensure that they are not approaching that area somewhere others. There are several interesting areas

which have developed by understanding the olfactory biology over the years, and not only that we have series of olfactory memories particular smell help you to associate with the particular event at particular time, because most of this smells or chemical sensors get stored at different parts of the brain in a different fashion ok.

So, there are traces and based on that you can even identify an individual. So, see for example, what I meant by that there is a associativeness, associativeness means say for example, somebody put on a perfume suppose your respective boyfriend or girlfriend has a particular perfume. Now he or she puts on that particular perfume on a x y z date, you smell that somewhere else where individual is not there in front of you right, you smell that and the face will appear in front of you, I know this smell ok.

So, in other word visual information say for example, can cross talk with and olfactory information, not only that to auditory information. Now you realize the complexity. So, when we had talk about memory I told you one information could be split up into different component of visual componential, factory component, auditory component likewise so on and so forth. So, it is a big function of one particular whole set of information.

Now, what you get it d, d x by d y one component. D x primary d y prime second component likewise. The different component of differentiating the signal, and when you have to recollect the whole thing what you do you do an integral of this whole thing of this different functions.

So, in inherently if you look at the nervous system it is all about integral and differentials of signals. This is how the whole system with (Refer Time: 20:17) we talk about olfaction, whether you are talking about memory acquisition, whether you talk about vision or whatever modality, you pick up, I will leave the modality for your wisdom. But what I want you is to think slightly beyond the scope of the text book, that how information coding is so very critical. How I mean think of a stuff, a dog just by sniffing can figure out this is a stranger the other person is a person of the house.

So, in other word if nature has done that nature could also be cheated. This is one project I will share with you. Say for example, we talk about insect we talk about repellent say for example, I talk about insect attractant.

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So, insect gets attracted by, say I know this insect x is insect is kind of you know damaging to the crop. Now I have a molecule say which is an attractant. But I know this molecule y is derived from the plant which is attracting it. Plant give out this molecule y and x the get attracted.

So, whenever this plant is flowering or whatever it is doing forming see it sends out that particular molecule y and the insect comes and destroys the plant, fair enough? No issues. Now what I do is, I am a one very clever shrewd and a big cheater. What I do then I have this box I know this molecule one I synthetically make a lot of y or I collect lot of yes from here, now what will happen? Now if I know that this insect is exclusively attracted by the odorant not by the visual. So, there are 2 options you have to realize, either the insect knows that this particular tree is or the plant tree or the herb is now in a flowering stage. So, I get a visual q and I am going to run towards it, or it is exclusively depending on the odorant or both, how you would answer that question?

So, you can have a box from where this odorant molecule will be coming out. If it is exclusively dependent on this you will see the insect flocking in towards it. And if you could need this structure like those flower artificial flower from where it is coming out, then you can even distinguish if the number of flocking insect is more here it means it is using the visual as well as the olfactory cue stands for visual o stands for olfactory cue.

So, these are some of the very interesting questions what now several scientist across the world are trying to address, how we can you know do things in a very natural way. In other word the doing it by bio mimetic sway, you are mimicking nature natural mimetic.

So, I will close in the olfaction here, and next class we will go to the visual system, and then the sympathetic and parasympathetic before moving into the cardiac system.

Thank you.