Animal Physiology
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Lecture - 30
Long Term Depression

Welcome back to the lecture series in Animal Physiology. So, we are in to the 5th lecture of the 6th week. If you remember in the last lecture we started talking about one of the memory modules which is termed as Long Term Potentiation.

So, what we observe in long term potentiation is to summarize it. So, say for example, a information is coming from a source at a very intense rate and it get to a point where that is being received. At the receiver end over a period of time the electrical activity of that receiver end becomes higher than normal, in spite of the fact that there is no more signal coming from the sender side.

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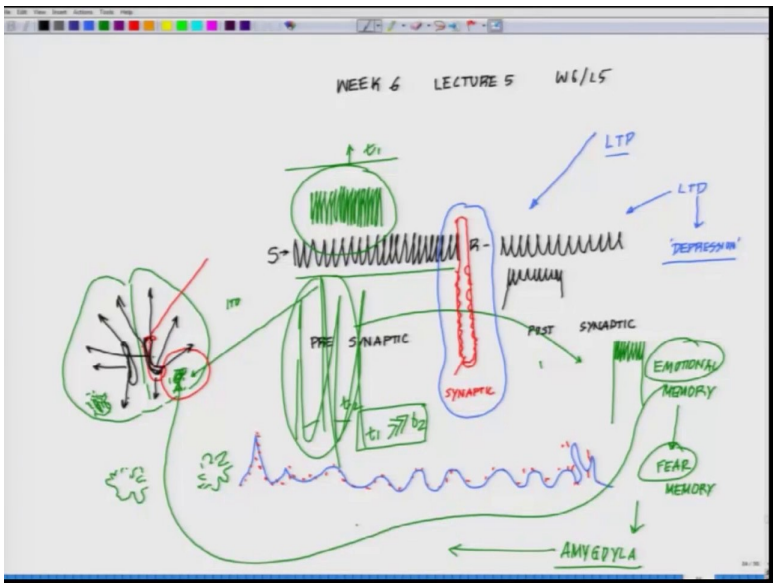

If you just recollect back what we talked about if this is so we are into week 6 lecture 5- W 6 L 5. So, here we have a sender of signal, here we have a receiver of signal, there is high train of signal which is coming, it is a very high train. So, automatically this is from the centre and receiver start to respond to it accordingly with respect to time. But after a point there is no more signal coming from the sender is still receiver is kind of responding.

So, what we do not know that is this processes a presynaptic event or a postsynaptic event, because sender in this case is a presynaptic part and receiver is the postsynaptic part. But what is commonly believed is that between presynaptic and postsynaptic there is a synaptic zone or a synaptic space, and it is being believed that at these synaptic spaces are synaptic zone there are some form of permanent changes which are encoded.

Again this is just, belief system currently because to tell with certainty it is very difficult because, again and again the question will come back what are those permanent changes if you have to define memory physical basis or if it is some other form. Because as of now as I was telling you guys in the previous class that whenever we talk about memory we have a physical understanding, like we always believe like you know on a memory neuron surface there will be inscription just like lithography you know you have some kind of dots points or something and you can decode that info back.

Just like what used to happen in those of you have not seen that long player olden days where you use to have a tip which is tap on and that way the song used to get recorded. And then if you exactly follow the track it is something like this. So, for example: there used to be a tap tapping and tapping used to you know store information based on the sound waves on a membrane like this.

Now if you playback this thing in a, you again start to play and follow the track it will generate exactly what you have stored. So, this is what we talked about whenever we talked about the permanent changes or at least cause a permanent or some kind of a change which is long lasting which is happening at any surface that is why decode it as a memory.

But, if the case of biological system this as of now remain a mysterious thing that where that permanent change is happening; is it at the level of a DNA or is it at the level of a protein or is it at the level of a membrane or where. Or there is another option: is that the system is governed by some wave phenomena, where many of the quantum mechanist have been exploring.

So, at this stage we are in no position to understand what is happening, but definitely in an in vitro setup this long term potentiation or LTP phenomena is being seen and currently till we have any better model to justify it we do believe that- again mark my

word very carefully we do believe that long term potentiation is indeed a process of memory accusation, but then comes a second situation.

There is another model which was suggested, which was just the reverse of it which is called long term depression and D stay stands for depression. So, long term depression is a much more practical situation. So, see for example: you are walking and on some dark and you just saw snake moving through, maybe you have seen that snake for one millionth of a second or a fraction of a movement. But, that information gets into your brain in no time. And there are certain areas of the brain where that information gets decoded so fast that in spite of the fact that was not an intense signal in terms of the frequency or time, but there are certain parts of the brain which become excitable at a much lower hertz or frequencies- they become hyper excitable.

So, in other word: if you look at this plot what I was did. I told you there is a high frequencies stream of informations, it is something like this, pretty high frequency is coming through it is something like you have to remember a some say formally of mathematics or some theorem or some laws you are studying intensely or you are going through certain manual and you have to intensely remember everything or remembering a poetry. So, it is a intense process what you are performing. It means you are like really getting deep into it.

Whereas, I give you a counter example when you see a snake or somebody just showed you something which could scared the shit out of you, that event unlike this out here if you see that event will be something like this. Just a moment, so if you see the time of the signal coming this definitely if I say it is a T 1 and this time if you see this is T 2. Definitely T 1 is reasonably greater than T 2, very reasonably greater if you see this compare these two green stresses. But, there are parts of the brain with that fraction of a moment there are areas of the brain which gets pretty hyperactive, even with such a low stress such a low and such thing can happen in two situations. I will come: one is what we call as emotional memories: and the area of the brain which emotional memory, fear memory. This part of the brain whether it is an emotion, whether it is a fear, fear factor whatever is govern by a zone called Amygdale. The name it got because of an enzyme called amygdelacia which is coming from one of the nuts. So, it is a something like, the location is somewhere out here it is a nut shaped organ pretty diffused it is not that like

you know something like walnut shaped. So, the structure is something like this. As you have seen the surface of the walnut it is much more gyrations and everything.

So, this is the zone where it is believed most of our emotional memories, memories of sorrow, memories of depression, psychic attack, happens. These are the zones which or even fear memories are stored. These are the zones where this kind of long term depression phenomena has been observed. And the person who was involved they very early people who have worked one of them was Eto, who was instrumental in reporting this kind of thing. Later there is another gentleman who works at Salk Institute Terry Sejnowski is also he has made some significant contributions in this area.

So, there are several people who have been working in this other area, but this is another aspect of this long term depression. Long term depression could also be observed in those parts of the brain which helps you to recall some of the very trivial things to, something like you are riding a bicycle. And if somebody ask you that do you remember that when you have to put your paddle your right leg and then the left leg and likewise. So, you will laugh you know, of course you know it or you are walking you know there is a pattern like you know right left or left whichever you want. And that pattern is kind of coded into your system; you really never need to recall that how you are going to ride a bicycle. I mean most of you if I believe.

So, those kind of memories do not need any kind of recall process. You just do it you know as simple as anything, you do not need any kind of recalling or any kind of those kind of information, those areas of the brain which decodes these kind of things falls under long term depression. They do not need it is or periodic of time so they do not may not be an just an impulse, but something like you learning over it. And then that area kind of gets activated almost even without your realization.

So, both of them have a one commonality if you think of it. Like without much of a that area I mean you do not have to really recollect anything that how you are going to ride a bicycle. And exactly the same way a fear, even before you think you know that fear gets you of thinking of something. So, it seems it seems to a very contrasting thing, but its seems there are areas of the brain which gets activated at a very low stimulus or almost most stimulus.

Why does on the contra I give a situation if I ask you know; what is say you know Jarden process or Jarden apparatus or if I say explain me what is Markov Chain or if I ask you some very fundamental aspect of electrodynamics or if I ask you explain me the whole works of Charles Darwin. It will take you some time I mean unless you are teaching that is subject every other day you must have read it, but you know it is very unlikely that on one shot you are going to you know talk over. If yes, some people can, but most of us cannot.

So, it means for some of the survival strategies, so one common thing if you look at is some of the survival is strategies. So, another survival strategies is fear factor; fear it is a survival instinct or some day to day habits. We do not really need to spend a lot of energy to recall that process, just with slight stimulus you can do it and even that stimulus you really do not even feel that you are actually recalling something. So, you are in front of the bicycle and sat, you know how to ride it; it is not a big deal. Or same way with a car or those who are regular driver, regularly driving and just sit in the car or you wake up in the morning and go in front of the mirror in the rest room and you start brushing the teeth. So, no one tells you that you take the brush you are going to do with like that or definitely most likelihood you are going to do it like this, right.

So, these are some of those aspects which we are yet to really understand they are induct molecular mechanism. And moreover a still the central question remains out there what is so unique about this area or even within the hippocampus if you look at it, it does shows you the stresses of long term depression. But does these things, so couple of question: does this thing happen in real animal, in the real life is that the way we acquire memory and if it happens what it leads to, what kind of changes it leads to? But one thing is clear what is appearing as we are travelling in this area is that.

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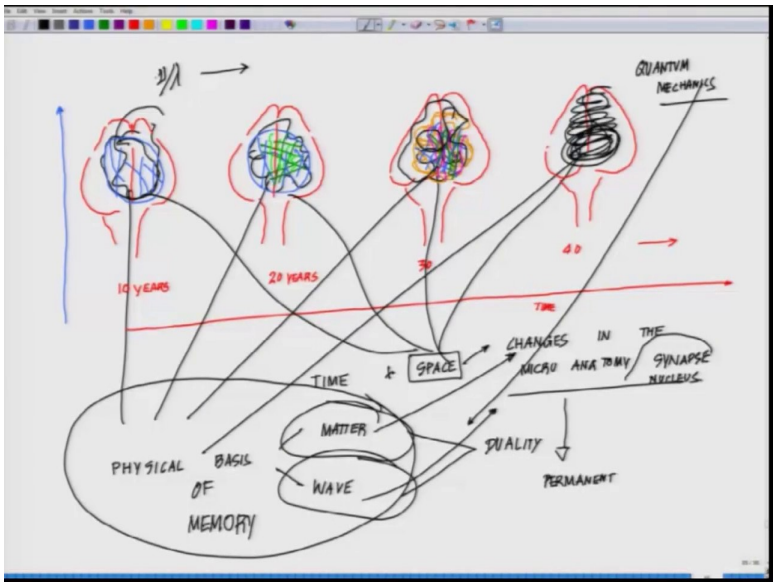

Say for example: brain is a system which is function of the space and time, what does that I mean? That means say for example, let me just give you a very graphical representation that will make more sense. So, just give me couple of minutes, let me. So, let us assume four different time points at some point of your life. Say for example, I say this is your at 10 years, this is your at 20 years, 30, 40, and like on.

Now, in your x axis you can draw the time. This is the time, you will go to 80, 90 whatever how many years over you live. So, out here in the network properties or your thought process over period of time, ok see if this is the summation of some kind of someway I can quantify that. So, these are the information which are stored. By this time this whole thing will have the old information as well as a set of new information getting into it. And from these two mix of green and blue there is an emerging property which will come which will be a new set of understanding of the system, for which you do not need any additional information right. It is all coming from already existing one.

So, similarly this pattern can go on and on to a point like, so this is what you acquire age of 20 and this is what you acquire at the age of 10; if these are the traces then now you are acquiring between 20 and 30 something like this. So now, all these thing mix up and it creates another set of pattern out here.

So, if you have somewhere other to distinguish between for example, a something is changing it shape in the microstructure. So, if I assume at 10 years the detail

microstructure of your brain shifts from 10 years to 20 years and from 20 to 30, the internal microstructure of synapse formation synapse you know build up within the synapse the connectivity changes. So, if you see over period of time which is your x axis and space, in this case space is this space- space of the brain within the brain. So, we see within this space you will have changes in the microanatomy.

What you do not understand those changes in the microanatomy at the level of synapse or even some of them at the level of nucleus or in other word DNA how those thing becomes permanent. And when I say emergent property, so emergent property is that suppose- if I could give a shape to your memory structure like this over time it changes and then over time it further changes much more complex as you move on, on it changes.

So, your sing, your brain is intact, but within it there are some permanent changes which are happening, which are function of time and space, the network behaviour changes. And the central and the fundamental question which will be bogging for centuries to come will be what are those permanent changes, what is really memory is all about, what is if this, this, this, what are those physical basis. Is it at the level of matter, in terms of matter I mean any kind of sight to architectural changes or it is at the matter of wave. We do not know.

So, that brings us to almost like duality, a particle nature or a wave nature. And we just do not know this. Is it the whole systems wave functions changes? Whole system you know vibrate at a certain wavelength or frequency all there it keeps on changing at every microarchitecture we just do not know. And this if I assume it right, just like in physics how the quantum mechanics evolved this is precisely is the point one day in a distant future biology will evolved because this is the fundamental question in biology that; what is the physical basis of memory? Is it some kind of matter or its some kind of wave or is it a duality. And this is where people from quantum mechanics are so keen to understand what memory is all about.

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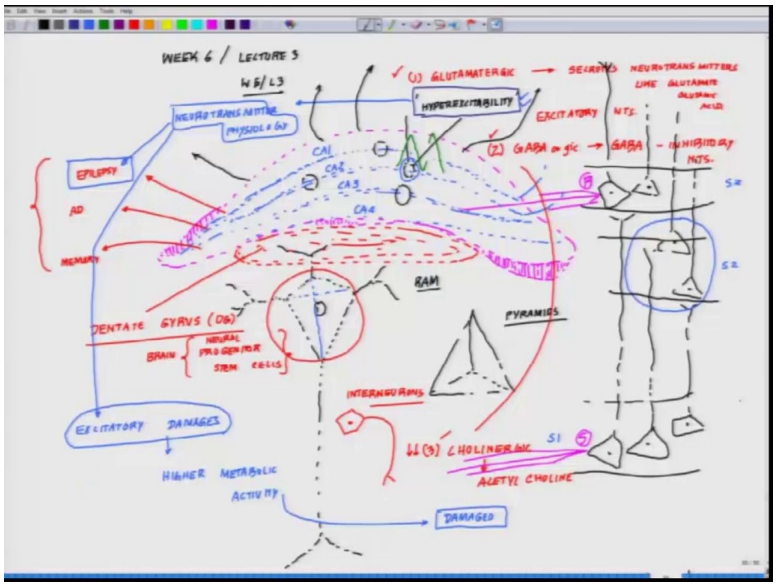

So, at this stage I will add one more piece of information and I will close in on this. So, another theory is that from hippocampus- this hippocampus acts as random access memory of the brain and from here the memory traces are stored in different parts of the cortical region.

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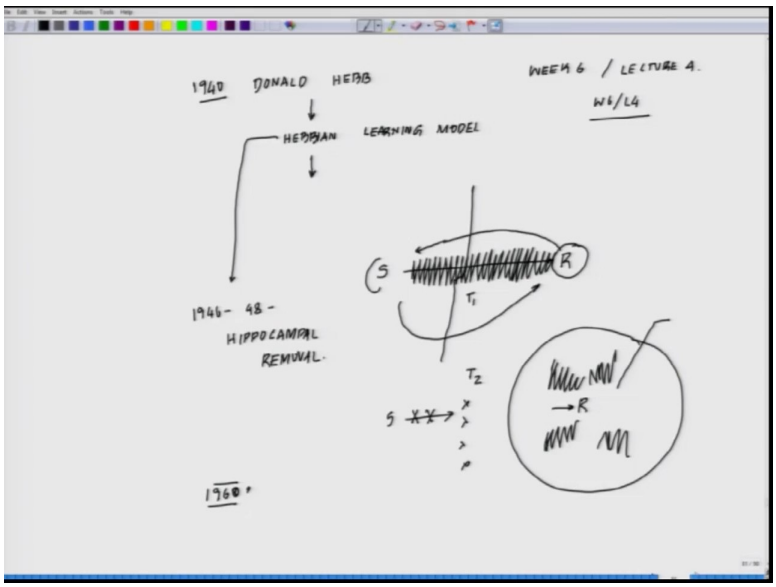

Again how this happens we do not know, but this is what is the current believe is or current. Say for example, something is getting processed here at different parts of the brain they are getting stored. How these memory stresses are travelling to different

places, what are those functions, we do not know precisely. But it looks like something like that is happening. And the challenge for the neurophysiologist future will be to answer some of these questions and if you ask that what are those big questions one mankind is, mankind does, I has to answer definitely this is one such question.

So, then comes what is loss of memory. So, I will close in here next class I will start the story of those souls who lose their memory. What does that mean, and what is the physical basis of it, because probably some of our answers will always come from those individual who goes through this ordeal

Thanks a lot, and thanks for your patient listening.