Animal Physiology
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Lecture - 29
Long Term Potentiation

Welcome back to the lecture series in Animal Physiology. So, we are into the sixth week and we have finished the three lectures of the sixth week, where you knew the fourth lecture sixth week.

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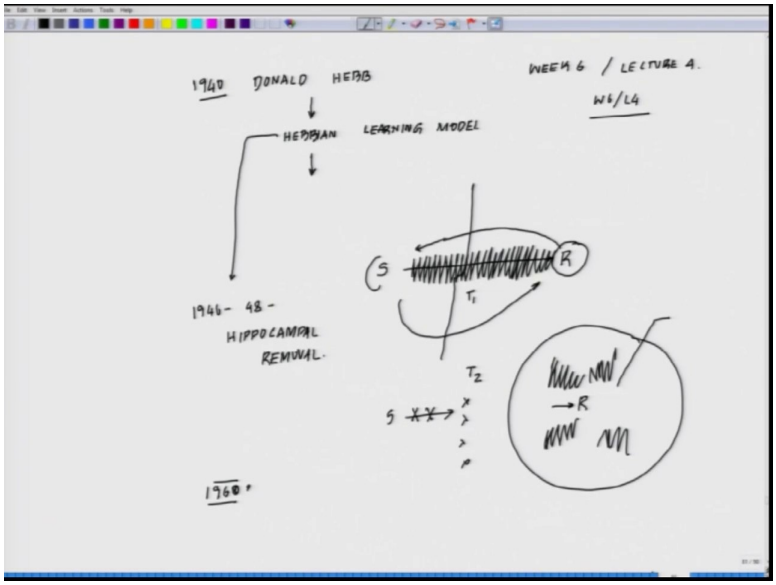

Week 6th lecture 4 W 6 L 4. This is where we are.

So, when I concluded the last class I told you about the most accepted at that time the Hebbian learning model. What was Hebbian learning model? So, Hebbian learning model is something; it is a purely mathematical thing so I am speaking here right. So, suppose I am one subject A and you are the viewer say I pick up few viewers B they are the viewers Now, suppose I am talking very intensely and a viewer is listening very intensely; I am talking very intensely, I am presenting intensely, a viewer is listening to it very intensely. A time will come when even I stop talking the viewer will be get that circuit activated, where the viewer will almost listen to what I am telling. Or not only listen to what I am telling it means even if I stop sending signals the viewer will be

almost picking up signals, it means the viewer is processing the information at a different level altogether

So, what does that mean? That means, I am sending a signal you are receiving a signal; very sensory thing not a big deal, right. I am speaking your ears are responding, your processes in the cingulated cortex its fine. Now how you define a situation? I send a signal, you receive the signal; I will stop sending the signal, but still you are hearing the voice. That means, a part of a my information got stored in the brain so intensely that you can kind of you know even I am not talking you are still listening. You have to just think over it for a minute. And this is not hallucination I am talking about you are not listening to voices randomly. You are incensing to that subject.

So, think of when you are studying something very very intensely, no you have to cram it you have to really know clear this exam you have to do this and your just into it, you are just mad into it. When you shut down the book, trust me many of you without any doubt I can many of you will be like you know yes and this is one happen like and all like. So, it means you are no more receiving any information from the book, the book is shut down, but you are there or you know in the exam hall. I mean exam hall you do not have any book right you are sitting there, but then you are recollecting the things as if that information from the sender which has been received by the receiver; receiver has kind of trigger that circuit in such a way; receiver circuit has been triggered in such a way that it is continuously processing that information.

So, in other word if I had to put it like this: that means, here this is the sender S and here is a receiver R, sender is sending signal receiver is responding to the signal. But this is time T 1 sender is sending very intense signal receiver is responding. Time T 1 sender is no more sending signal, your receiver is almost like receiving signals. Sender is no more sending any signal, right. So, it means the circuit of the receiver is now at a different level altogether from its base line or it almost looks like that it is asking their sender to send more signal or it is cross talking cross communicating which is physically not happening in the situation.

What is it? How that happens? This was the very very first learning model which was given by Donald Hebb; Hebbian learning model. And though this model was really a popular model, but there is no way that you really can test this model; that what is

happening and how it is happening. Does the state of these receiver changes, does it truly changes and if it changes how it changes. There is no direct way that we could have approach this problem.

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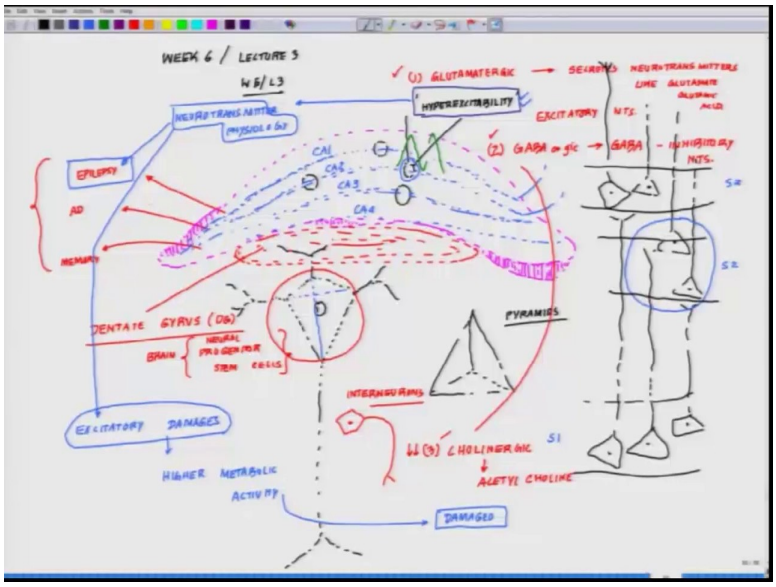

With the accident or with that exploration of the Canadian patient would happen when you remove this part of the brain the hippocampal region you lose or you lose the ability to process any further information or a memory storage is kind of getting compromised.

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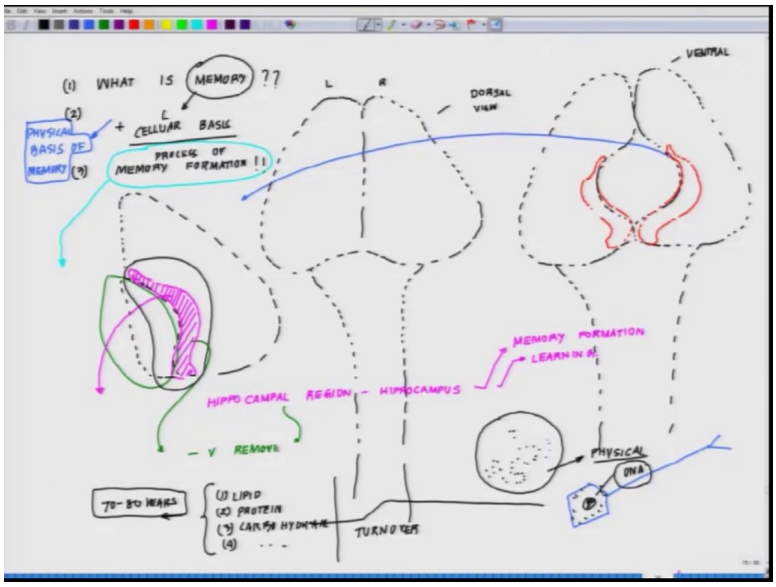

So, that gives us an option to test this particular tissue, this particular hippocampal region in isolation. What is the role of hippocampus in, if at all in memory storage? How this neuronal circuit works? So, there was an experiment which was done. If this was around 1940s when Hebb proposed this

There was another set of experiment. So, 1940 somewhere around 1946-48 the hippocampal removal take place and we will subsequent things. So, around 1968 62 or 1960s; let us called 1960s there was one experiment which was done. The experiment was simple; I will explain the experiment that will sense.

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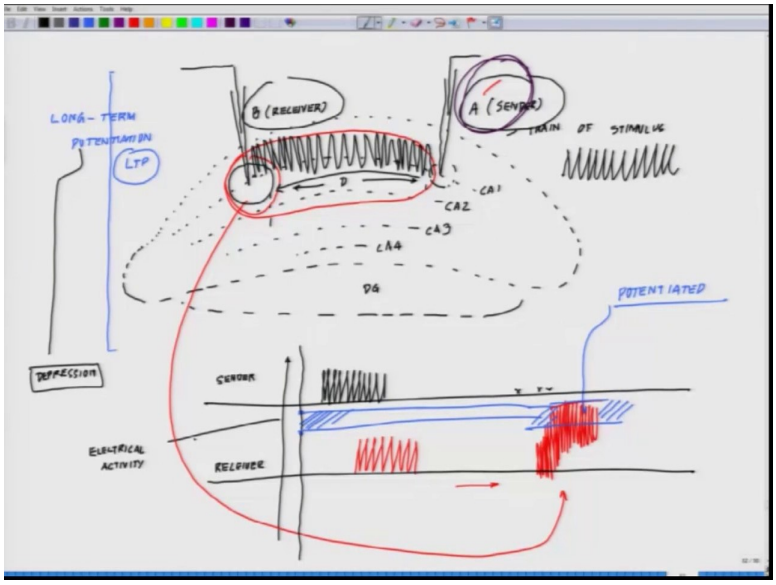

So, from the guinea pig we remove the hippocampus kept it to then synthetic artificial condition. What I meant by artificial or synthetic condition means, that hippocampus was kept in a saline situation where it will not die out or anything for like 24 hours or you know whatever.

So, I told you that it have this kind of pathways they are CA1, CA2, CA3, CA4 and you have this dentigerous: DG, CA1, CA2, CA3, CA4, likewise. Now the experiment which was done was very interesting. What did they proved an electrode here, and they proved another electrode here. And assume one electrode set as A now other one as B or say A is the sender and this is circuit which is connected, remember. So, if you just recollect back when I do this I showed you.

So these are say for example, you have now in your light of this you prove an electrode like this and you proved another electrode assembly like this. So, this is the sender electrode, this is the receiver electrode. So, you have different level you put it now coming back to them. So, this is the sender electrode, this is the receiver electrode.

Now, from the central electrode they give a train of stimulus. What I meant by train of stimulus? So, they are leaving this excitatory or the pulses. So, automatically what will happen? Neurons in this region will get excited and well start shooting action potentials and which will be travelling all the way with the gap of time out here.

So, automatically whatever excited to reactivity is or whatever activities electrical activities which are happening will be picked up by the receiver. So, what you people you see is- so we will have two channels: this is a sender channel which is this one this channel and we have a receiver channel which is that second one, receiver channel. And y axis is giving us the electrical activity.

Now, sender is sending signals: this is a sender sending signal so automatically with certain time delay because it has to travel this distance, there is a distance involved in it between this and between this. With the certain delay you this receiver will start receiving signal, up to this game was all fine.

Now imagine next situation comes, this continues for a while and then the sender stops sending signals. So now a situation I am telling you after certain period of time where sender is no more sending any signal, there are no signals here but still what you observe in this side out here, still there are signals coming here.

Now, the question is sender is no more sending signal, because I am not sending any further signal here which I have make full control over it; how come receiver receiving signal. Has something happen in this circuit, somewhere? How that is happening? Because there is no four signal and not only that without time it is observed that this signal intensity is slightly higher than previous this line valid. So, how come that happened? There is an increase in the base line level, so neat increase; if in terms of the quantity, if your y axis is giving you the quantity so can you really quantify it. So, how come these increases happen?

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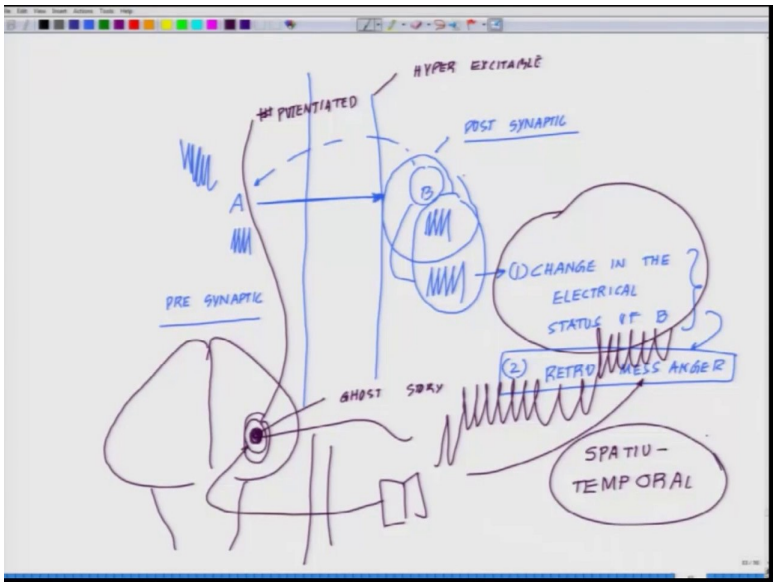

So, if you break down the problem simply it will be something like this: A as the sender B is the receiver, A sending signal B receiving signal; but then A no more sending signal B is getting signals.

There are two possibilities: either there is a change in the electrical status of B- one. Two- this B is sending certain retro messenger to A to ask it to send more signals which artificially I am no more sending, which we do not know. So now, B has got this property developed because of that initial change in state which leads to this. We really do not know does such thing happens or not. But it does happen what we know is this process. There is the high frequency signal giving to A then after; so there is certain particular hertz which are given to a which leads to a different status change in these signal processing.

So, if I consider this A holistically as presynaptic then B is post synaptic. In that situation this as of now debatable topic that this whole process; so in other word what is happening if you look at this picture just the previous one. So, this system post such a treatment becomes potentiated. Or in other word the system is much more at a different higher level. And this process of information transfer which is believed, again mark my word very carefully which is believed to be involved in the memory formation is called Long-term Potentiation- LTP in short.

So, long-term potentiation is one such model which is believed to be involved in the information processing and memory formation. Believed to be, really does that happen or not we do not know. But what we know is as of now is that definitely there is a change in the state has to happen if memory has to be acquired. And from your day today life you can experience.

If you are intensely into certain subjects by you are reading something, just take a simple example of the book. Suppose you are reading a ghost story, when you are reading your processing then formation right you feel like scare or whatever then you kept the book, but in the night you feel very scared of ghost, as if everything. So, from where this signal is coming? And you are so scared that then you keep the lights on and you do many things. Where this processing is happening? So, you have acquired information, so that is what I meant by potentiation.

So, it means we break down the problem. It means somewhere in the brain; so you receive the signals so there is a ghost story. Say for example, information of ghost story is stored in this area of the brain you read the book; you read the book information came and you stored it here. Now, this area become potentiated or become hyper excitable.

So now, you do not have the book, now its night sleep, but this areas activity is now higher something like this, something like this and you are not receiving any information. So, in other word the excitable state of that network completely changed; its frequency of firing, its way of working is now no more in your control. It has got potentiated, that is what I meant by potentiating a circuit in that whole process realizing.

So, this and not only that this is going to happen a day. Whenever in your life you remember that story or anything unless you overcome it, it is going to bother you big time. And as a matter fact much of our psychological problems if you look at it is we hardly have any control about these kinds of events. We see something, it goes in our memory- oh no if this happens we are scared. We experience the event, we read about a event, and we developed a kind of a part of the brain kind of get potentiated; that is what I meant by potentiation can you get activated. And there is no way that you really can wipe out that part and that is what shapes are as I was telling you is called the emerging property called behavior.

That brings you to be in like you know I am scared of something oh if this happens, get panic attacks. I mean so many things which happen. So, when I was telling you that the emerging property of the brain; what meant by that? With experience, with all these in force which are coming into your brain this is the whole evolving structure which is evolving slowly, gradually, and with respect to one parameter.

Now if you remember when I told you spatiu temporal summation; again this is the simple word, but it has lot of meaning- spatiu temporal. Means spatiu [FL] space temporal means time: spatiu temporal. So, different part of the brain which are in space they evolved with respect to time. What I meant by with respect to time? So, tonight read a story about ghost story, but this may haunt you for rest for your life. So, it means there is a time and a space, because part of the brain or specific space in the brain got potentiated by a x y z information from book or your grandma told you a story or a friend told you a story whatever you know it does not matter.

So, that grandma telling is that first signal which came to you or your friend telling or the books telling you that that is the first info and now try to correlate it with this one that is the sender; that grandma or that book or whatever is the sender. But sender has stopped grandma is not telling the story anymore right, grandma became quiet after telling you the story the book is shut down. But still your got down brain is functioning at a different tangent, at a different time in space.

So, that space of the brain which is storing now is does not need any signal any more, it is in a different state. That is what we call as experience and that is what we call as emerging property of the network, which emerging property is function of two things: space and time. That is where all the memory storage whatever. But we do not know what is memory storage,with absolute certainty I can tell you- we really do not know this. We definitely know which part of the brain if you remove, there will not be any further memory acquisition. So, you will only live with the old memories that we definitely know.

So, this particular study in around 1960s lead the foundation stone of understanding the synaptic phenomena or synaptic processes for what we today termed as long-term potentiation. But, this is not the only way there is another way to it what we call as long-

term depression. This is long-term potentiation, there is another way, another different model which is called long-term depression.

So in the next class, we will talk about the second model of memory called long-term depression.

Thanks for your patience listening, all the best.