How The Brain Creates Mind
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Lecture – 02
Brain-2

Welcome, I hope from the last lecture which was more general peep in to the way life happens, let us start on the journey of brain. You know this man Charles Darwin, last lecture we were questioning whether we are different from other animals, even when the genes are same.

So, as it appears of whatever we know of brain, there are no new areas of brain which have evolved from the chimpanzee to human beings in the 6 million years, but there is a difference in degrees and the quality and the way it has developed. So, the areas which human beings have in the brain are also present in chimpanzee although they may not be as functional as complex as in us and. So, like Darwin said that difference in mind between the man and the higher animals is certainly for a degree and not of kind.

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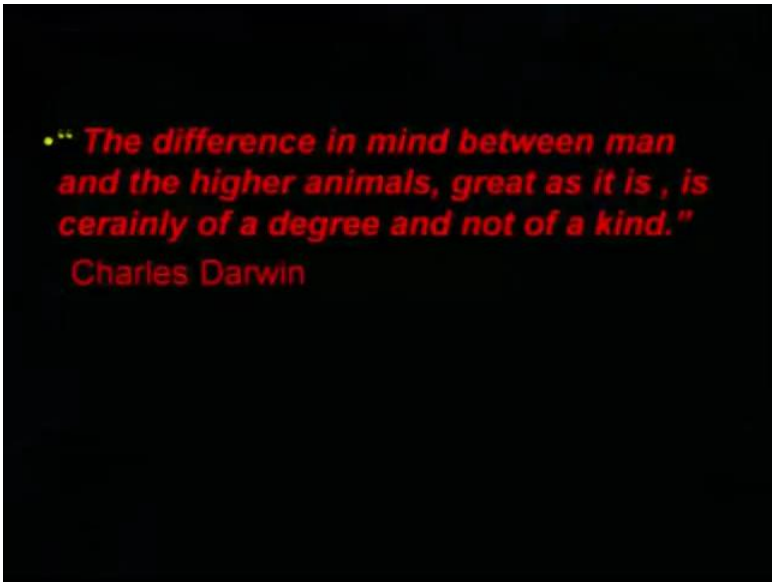

So, qualitatively we are on the same line, but the complexity varies. So, this is the universal fact, if you look at it just go back to beginning of life, if mentally you can imagine, imagine there would have been one gene; obviously, first gene would have been born somewhere, what was that gene doing, that gene was intelligent and smart enough

to know that, if I divide and I multiply, I will not get destroyed. Otherwise rain would have swept it off, lightening would have destroyed, it floods, stone falling on it, if it would have got crushed, but it multiplied and it survived and since then genes know, that to multiply to survive. So, that is how all the human population and all other species increase, you keep reproducing we are more human beings, will not get destroys all that genes want is to keep the species continuing, but with the genes something else came up the nervous system and this nervous system is present right from plants to silk cone to amoeba, even the simplest of the living beings have a nervous system.

Simple from simple to the more complex like human beings, they must have been the neuron also, the first neuron, so the first neurons do not multiply. Once they grow ones they have born they born it there may be repair in it, there may be differentiation in the shape an all, but they do not, but neurons started firing. So, neurons ones activated your brains ones get activated in your womb, it only shuts off when you die it does not shut off in between where you shuts off, we are gone. So, what do the neurons do neurons cannot be multiplied, neurons have two modulate behavior.

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So, the genes may reproduce, neurons promote behavior, that behavior leads to some consequences in the body and environment; these continuous message sending to the inner chamber all for what to take the information from the environment and to adapt oneself to the environment, adapt the environment to oneself, all to survive. Why survive

because genes want to survive and reproduce neurons act as a modulator, it keep sending continuous messages and changes to genes and that is how genes keep modifying, these are universal phenomena in all species.

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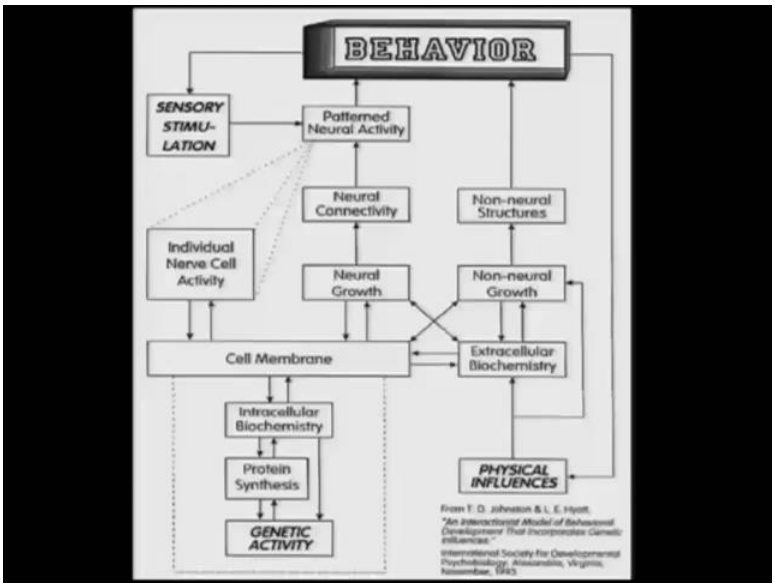

Now, look at it you can now some people there is a lot of philosophical debate which went on, especially with Descartes who said, that right from Aristotle time some people thought, that it is all mind it is all conscious and said that is a soul no nobody thought of brain in the sense of a structure, it is decorator said that, mind is different and body is different we do not know, whether he did the error or not although this, there is lot of writing which goes on which says that, it was foolish to separate them, but from many years believing on this the research went on, there was a group which was looking to the structure and there is a group which looks at the behavior.

If you look at psychology, although psychology still dictates our research, because the behavior of human beings was analyzed by psychologist and they give the definitions of the psychology, now even when we do physical research of brain, we still take definitions of psychology, the precursor of psychology was philosophy, and precursor of science was also philosophy, physics precursor of philosophy. So, all these people believe that, there is a mind maybe consciousness, which exists separate from brain we have to analyze, that is merest general way of looking at life, come down, come down to the brain there is a patterned neural activity as it written here, then there are non neural

structures like other part of body or in the brain there is a fluid and there are other cells and blood vessels and all, neuronal growth come down further, it comes to a single neuron or cell, then there is go within the cell, there is a biochemistry, there is proteins synthesis and genes this is ultimate reductionist thing, this is what I was telling you the way it happens.

The Neuron sciences are being studied, right from extreme reduction ism, we are talking about genes to behavior, which is a more general thing. So, there is a behavior, there are definitions, which take behavior then you go down to brain cells then you do imaging this was a big brain structure, this area, area specialized for certain function, there are certain areas specialized for other function, visual system auditory system, go down further you find 10 to the power 11 neurons with 10 to the power 15 synapses doing 10 to the power 18 operations per second, some people want to go down further look at each and every neuron and the initial electrical activity go down further he look at nucleus, how the signaling goes down there, do not get overwhelmed by these terms, I am just trying tell you right from.

So, if I raise my hand like this, this is called hand shaking, this is a behavior psychology would call it communication or greeting. Now come to level, this is level 1 go to level 2, then you find what is moving my hand, muscles getting signal from nerves. Level 3, nerves getting order from the brain - Level 4, why does brain want to greet this person? That is a social need, which has come out from within the brain, One further level which area of the brain is giving, this social need another level. What are the neurons which are firing there, at what range of frequency they are firing? Another level, which synapses and which neurons are actually connecting to each other; another level, which chemical went between 2 neurons to signal this, another level, what genes actually want people to communicate. See it is already and I have missed few of this level. So, really do it from behavior to total basic reductionist, this is the range of Neuroscience.

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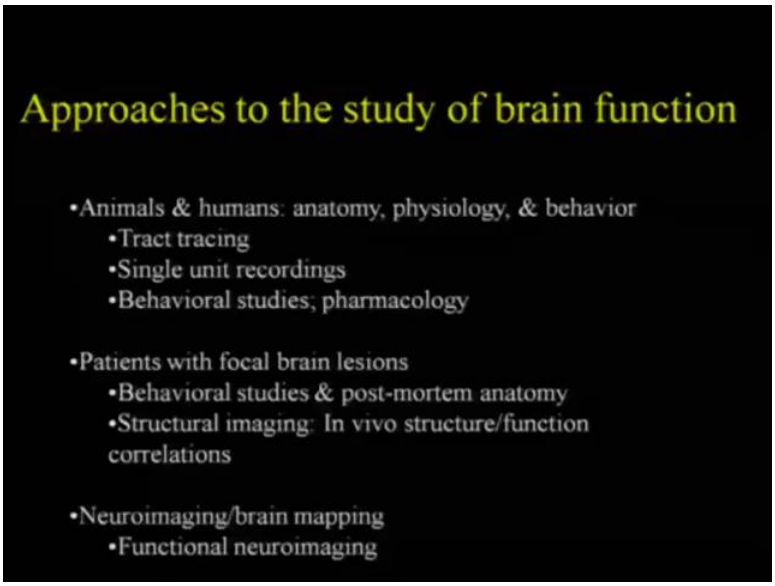

So, you can pick up whatever you want and that is how plethora of data comes up, these are the approaches, you study brain. Animals and humans, where is anatomy, physiology, tract tracing you can just, you can always revert back to this slide just have a look through this, "Focal Brain Lesions" Brain lesions are, if there is a brain damage to certain area, these are certain behavior which is altered, these was the initial days when people used to study, we found that people are behaving abnormally and when they die you do a postmortem, you find a certain area which is damage you correlate with that behavior, with this damage which has been replaced by imaging you must have heard words like M R I and City Scan. So, what was being done at postmortem, many years is back, decades back is being done by imaging in city scan. So, somebody cannot move a hand, it is a paralysis you got a city scan done it is on the left side, you find some damage on the right side of the brain, we all know this opposite sides control.

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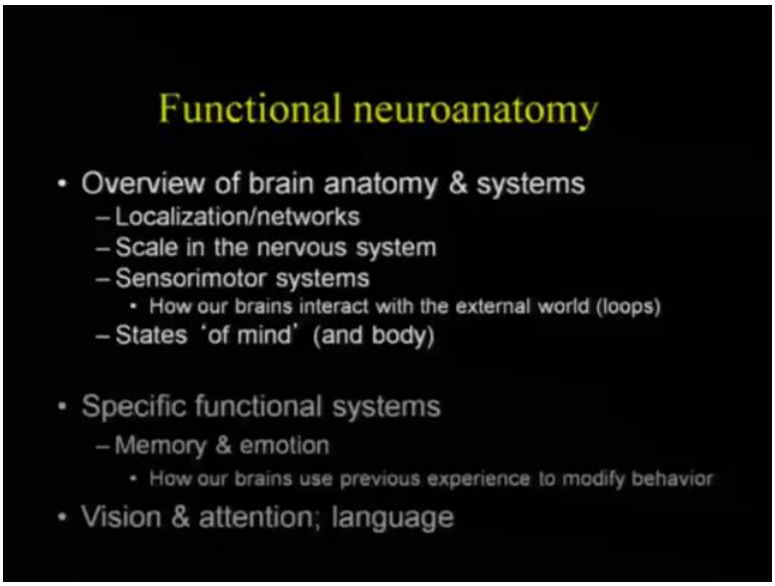

So, these are just broadly, and then there is something called "Functional neuroanatomy" the basic question which I was trying to raise, when I was showing you the previous slide, is that what is important, is the structure important or is the function important.

Functionalist will believe that is the function, people who are reductionist will believe is the structure, is the history important or is Geography important, now history and Geography I am just giving a simile, history can alter geography, geography can alter history because people get stuck in some area of the world and where they live alters the history and where they live alters the Geography also, but the best example has been given by computer, computer has a well laid structure of silicon chips and all and it transmits the movement in whatever 0 and one binary way of doing it, but when you put a software into it, the software really you are bothered about the hardware at that point and you are just bothered about the software, software really whether it connects to the hardware although the hardware is running the software, but for functioning you are not really bothered about the hardware, the some people say this, that this is the best analogy, but it has a flaw, brain is not like that because ones the computer architecture is laid down, you can keep loading software and keep running the software, you do not have to keep altering the basic computer structure.

Brain with every experience, with every action, it is the structure also which keeps altering little bit here and there, with every experience with every memory which goes

in, with every expression of your emotion with every expression of your action it is. So, the structure and function in the brain are almost entertained. In computer you can use the software and just give the machine and you can load whatever you want, in brain you can never take off the software you can never right from the birth, when we talk about the development of brain later in the presentation, then you will realize what is happening there.

It is. So, entertained, that a structure is formed by the function. Lot of this function comes from environmental interaction, the brain does not grow. So there is a genetic template which is common. So, brain the genetics grows the basic structure of the brain in the womb and then it is all the environmental reaction. So, the structure and function is very difficult. So, we talk of Functional neuroanatomy, we talk of localization, we talk of networks we have to know how the brain interacts with the external world, what are the states of mind, you may all know what different states of mind that you are happy you are sad ,you are sometime more aware, sometime you are just groggy, sometimes even when you have opened a book your mind is not there, sometimes you are thinking about things which are nowhere in your radar memory and emotions.

We will talk about memory and emotions in the second third week when we talk about it, but you look just look at it what are you if you try to analyze yourself what are you if I take away all your memory of all your childhood everything is happened where do you stand is gone is gone. So, human beings are actually existing in space in time if you look at it broadly, but in space and time and it is have sense of continuity because they have lot of fixed structure imagine if you are just if you have to leave say 2 feet above the ground and the earth keeps rotating under your feet. So, today you will be in Kanpur IIT tomorrow by the time you look down you will be in New York what will life mean to you there is no continuity lot of continuity of your life comes from memory.

So, you have to look at how a brains uses previous experience to modify and your memories also modify your behavior just to give you a simple example if you have a tiff with somebody in your life and you had a bad experience your mind says this person is not good may be this person meets you after many years my guess is for most people even before that person speaks anything he may be have changed then he may be talking good of you, but your bad memory will trigger it starts signaling you will always already become anxious and tight hoping that when again we are going to have a fight types and

that is what people do people assume in a top down thinking people assume that this person is always going to say this. So, even before that person speaks you already fitted the whole thing into your previous experience and you already reacted it may not be true and half the time you find it is not true, but it all require a certain amount of detachment to analyze.

So, in the true sense if you asked whether people can be objective you understand what objective is people say no why are you thinking why do you carry assumptions why do you carry this you should be objective in analyzing objectivity is very difficult to practice very few you people can practice it because it is your memory and emotions which are already firing even before the event is happened like you go to examination and all of us know when you go to real routine examination you do not bother, but if it is a real tough examination of your entrance or your JE or your IAS interview or something for a job you have this small butterfly in the tummy why is that your brain is already firing it already telling oh boss if I am asked a question which I do not know what will happen. So, you already raised your stack.

So, this raising stakes is a habit of brain we are still doing it and believe me when I ask you whether you are doing it whether you have a control over it and why are you getting anxious you will suddenly get jolted most of us say why I am thinking like this it is not important why am I have studied well or whatever even if you do not get a job it is not the end of the world you know this, but your mind is firing it because mind has because you have come just now for whatever age you have mind is they has been there for six million years or more than that and the modern mind has been there for 2 lakh years.

It has turned itself for what for survival. So, let us look at this what first look at the structure then will think about the rest other things, but it was always no. So, I that the way I am telling you brain is this structure modular right now if you ask me the brain is paralelly distributed modular structure, but the same time it has some hierarchy in the decision making it is structure is made such that this is the function, that we generate if the structure of the brain changes the function will change as it is sense now it always not.

So, this research has come in the last psychology has been there for 150 years this research has come in last 30 40 years, but in the last 10 years the whole thing is going the

well lives and bound because of technology because by politics has coming physics has coming lot of modulation is going on at one point of time people used to think their sight of thinking is heart poets still think the same [FL] you call in Hindi.

So, the poetry comes out of heart, but it cleared then it came to this, this is system of ventricles in the brain which have fluid people will not say whether it is brain or the ventricle and then as we moved on now we are clear it is brain more or less and Neuroscience is more clear that even the mind is brain. So, mind is in all this presentation we will use mind as an emergent property of brain we are not going to treat it separately also although the definitions are from Psychology.

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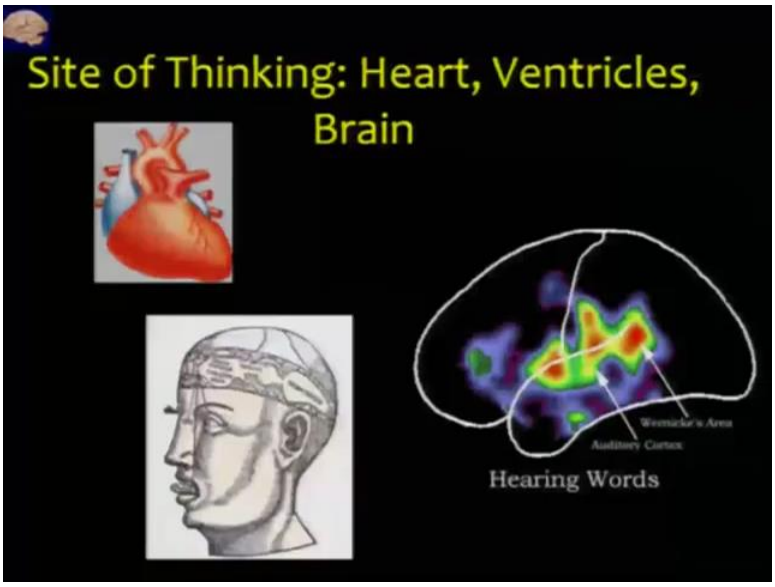

This is one of the images, which is from touch scan, Now we have technology which can tell us which part of brain a gets activated, while you are hearing words, there was a Gall now if you Gall brought out some interesting concepts call “Phrenology”, he said he was the first men to give this idea that, there are functions in the body of movement, of hearing of listening, of watching and all this, they have certain a specific localized area in the brain, but this was fine, event over the board and he said all these functions and areas can be judge by the bumps on the head.

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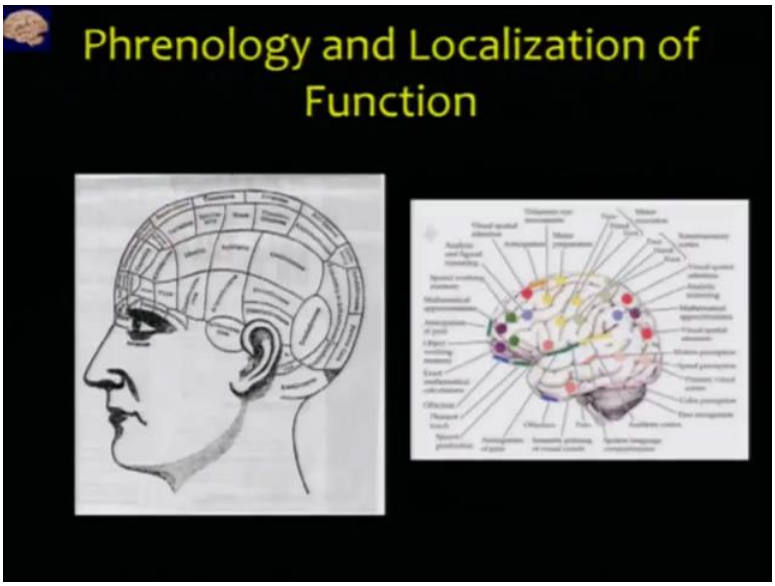

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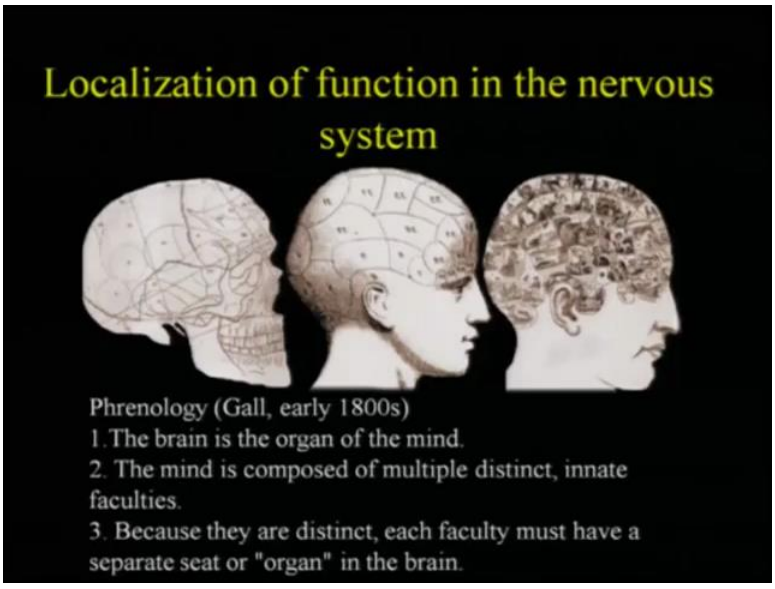

So, what you are saying is the organ of mind, perfect, the mind is composed of multiple distinct innate faculties perfect we also know this. Because they are distinct each faculty must have a separate seat or organ in the brain, partially true, but he all started correlated with the bump you see the last thing. So, it is a picture which says the base function is happening, there must be a bump here. Phrenology was still being practiced in US like lot of other things have being practiced astrology and this and that, but an US government is smart enough to tax it. So, whoever practices neurology will have to give a tax, but this was the basic idea of functionality of brain? In fact, if you look at the

modern MRI and imaging technique, they are just doing this they are trying to look in to what area of brain gives rise to what function.

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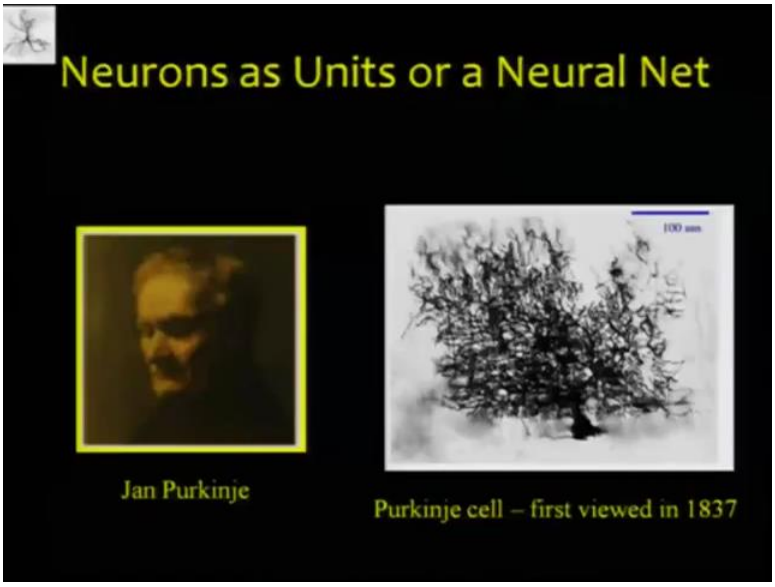

So, the origin was we should be thankful to Gall, although he was doing something else, but the big Philip came with the Purkinjes cell, this is Purkinjes cell is found area calls Cerebellum, I will show you that and then they realize that Neurons are the actual basic unit of the brain.

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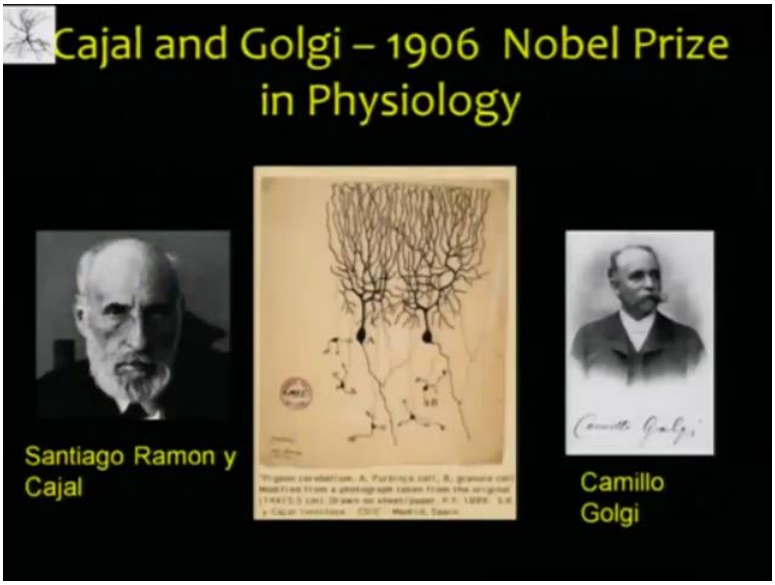

These 2 people are very important. Santiago Ramon Cajal and Golgi, by this time they had developed the stains, now Golgi said and they shared the Nobel prize, Golgi said using a same Golgis and Cajal found out, that they are Neurons and they multiple of the as you see in the picture and they are attached in the form of a network which is fine, then this is call Synctia; S Y N C T I A that, they are attached like this and then they are more attach like this wall to wall, wall to wall, like a huge mattress, but Cajal said they are not attach like a mattress, they are not attach like one side by side, is are there distinct unit each one of be the distinct unit and they form a network, Cajal proved to be right, but ones it was thought that wonderful if it is (Refer Slide Time: 22:27) unit, how do they get connected. Sherrington was working on the reflect section.

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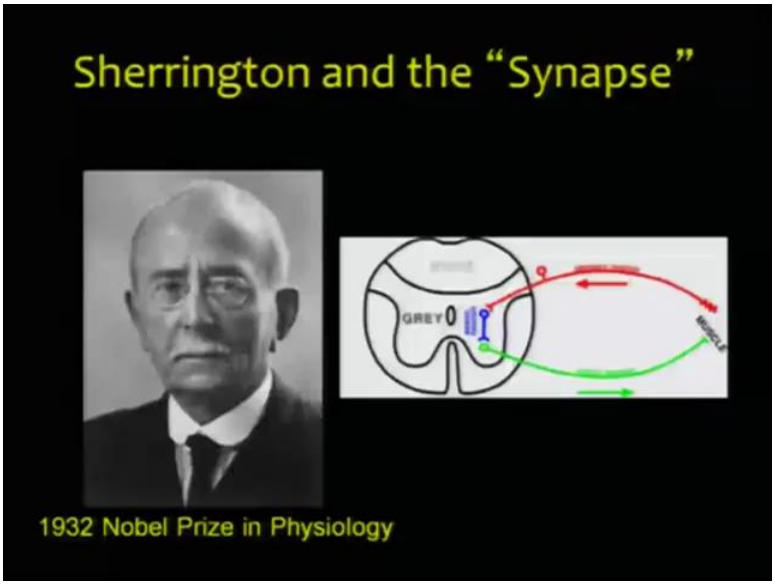

Now this is the reflection section Right, if you see the Red and Green arrows; these are spinal cord, this whole structure is a spinal cord, this within the circle. So, this1 nerve which goes out to the muscle and one which brings the sensation. So, if there is Pinprick suppose in your hand and your hands moves like this. So, the signal would go from this touch to a spinal cord, part of this signal will go to the brain.

So, the brain will know the pain or whatever and your hand will move even without knowing it, this is a Reflex action. Sherrington brought out the idea that, they are so many suppose, this whole one nerve cannot go like this, So what Sherrington did, he probably brought out this concept of synapse that, they may if there are neurons are

separate structures; how do they connect, they connect through what do you call "Synapse" this was a great leap, and now we know the brain looks like, this it is composed of cells called "Neurons", which are the main cells and they are Glial cells, which are supportive cells.

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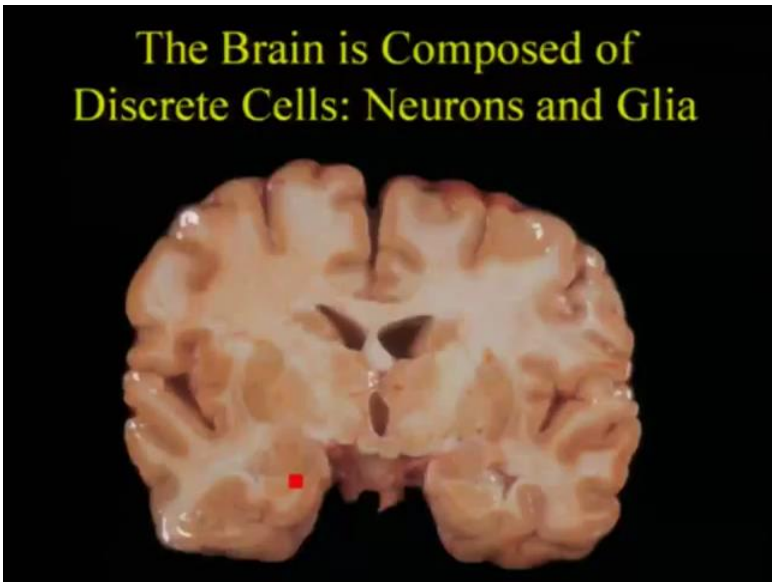

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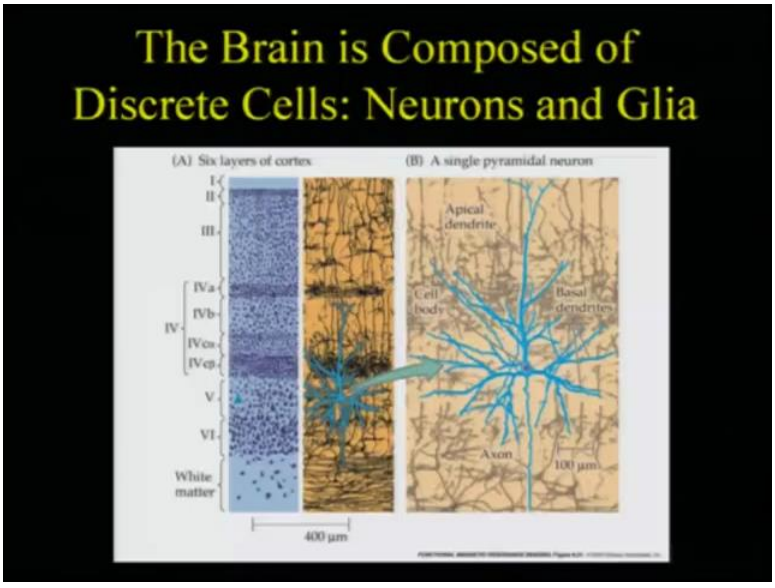

Neuron cell I will show you what a neuron looks like, but the whole brain, if you look is not gray they have, but a 2 areas one is called a Gray area, Gray cells, Gray matter and

other is White matter, the Gray matter are the bodies of the Neurons, let me safe I can show you Neuron and come back.

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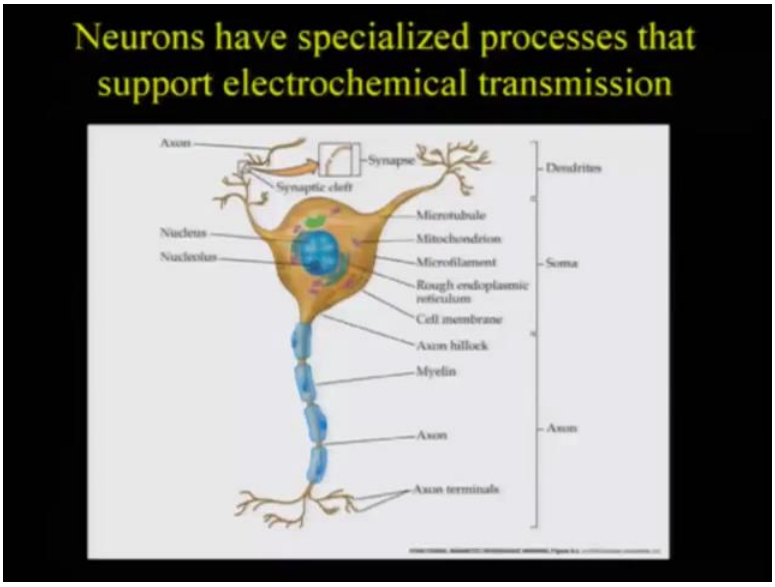

This is the typical Neuron, you see the yellow structure the body of the cell, this is a Nucleus the blue one, this whole thing tale which comes out is Axon and the wing like a structure which I going upper called “Dendrites” and then they are Microtubules and so on. So, 4th looking at the whole thing it is at between the 2 like this, you see this structure is Synapse.

Now, this is Axon, this structure Axon coming to the other Neuron, this ends on this dendrite of this. So, dendrites are like Antenna, Dendrites are like Antenna on which the Axon comes and this hole small thing is called Synapse, this again you can see it here. So, this is cell body these are Dendrites, this is Axon. Axons also (Refer Time: 25:54) divides into small (Refer Time: 25:58) Dendrite also I will tell you why it happens alright. So, this is 1 Neuron and to just give you the idea there are 10 two the power 11 neurons in the brain, the cell body of which are arranged in the Gray matter, and the Axons come down to form the nerves some of them are very long, some of them are small, which end in the brain itself. Some of them come down to Spinal Cords, some of them from a Spinal cord, they go to there are cell, the cell is what is are also found in deeper structures, but largely, we find it in the Cortex. Cortex is consider to be the brain and. So, it is arrange in 6 layers right.

Let me show you this 6 layers, this is a cell body, there is a single Pyramidal Neuron which is in the layer 5th. So, what goes into the brain; the sensations are mostly in these layers 2 3 4 what the brain directs to do, is starts from the layer 5, which is a pyramidal cell do not burden your head too much with it, but you should understand; what is happening and layer 6 leads to some deeper structure. So, it is a huge network of input coming and output going, not only within the brain, but outside the brain to nerves to a Spinal cord which gives direction to the other parts also, and then this White matter forms the nerve.

Now, imagine we have a column and they are arranging in columns, Functional columns there is no distinct sheet around each one of them, the columns are like this.

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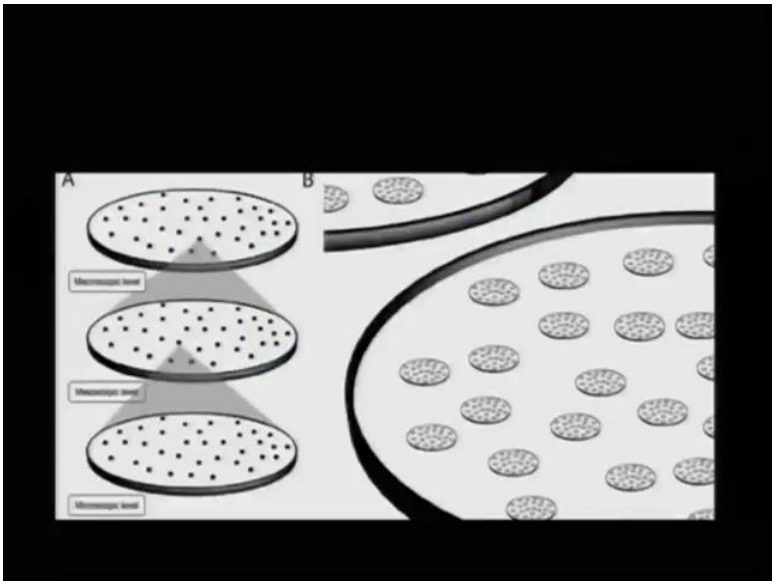

They are small mini columns, they are Micro columns, and then they are Mini columns.

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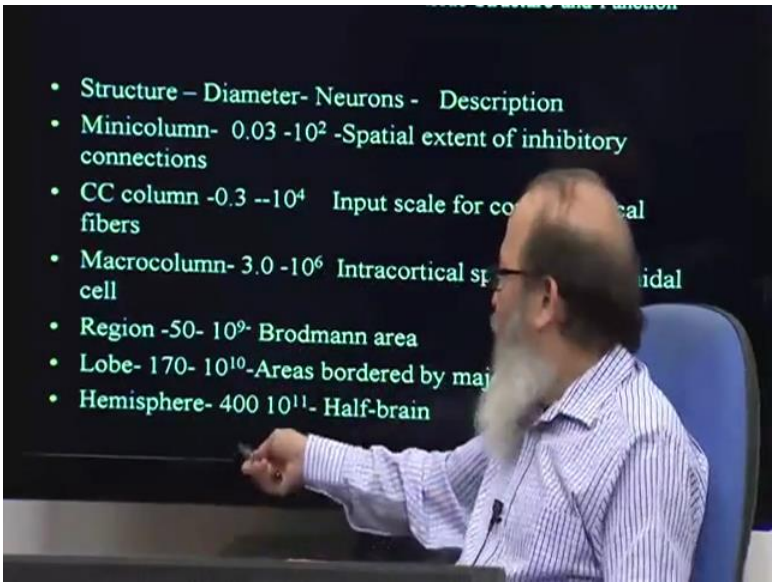

And then they are micro columns just to give you the dimension mini column is 0.03 millimeter, it has a number of Neurons is 10 to the power 2, then this Cortico column are within the brain, 10 to the power 4 Neurons, Macro column 10 to the power 6, these unite to form a region of the brain, where we talk of functionality, there is something call "Brodmann area". Brodmann was the person, who using a certain stain, looked at the brain and could define wide areas, which have been number from 1 to 44 and 56 and all; to which different functions have been assigned region it increases 10 to the power 9 lobe. Lobe means, I will just tell you the broader structure of Frontal lobe, Parental lobe, Occipital lobe and then their Hemisphere - 10 to the power 11 which is half the brain.

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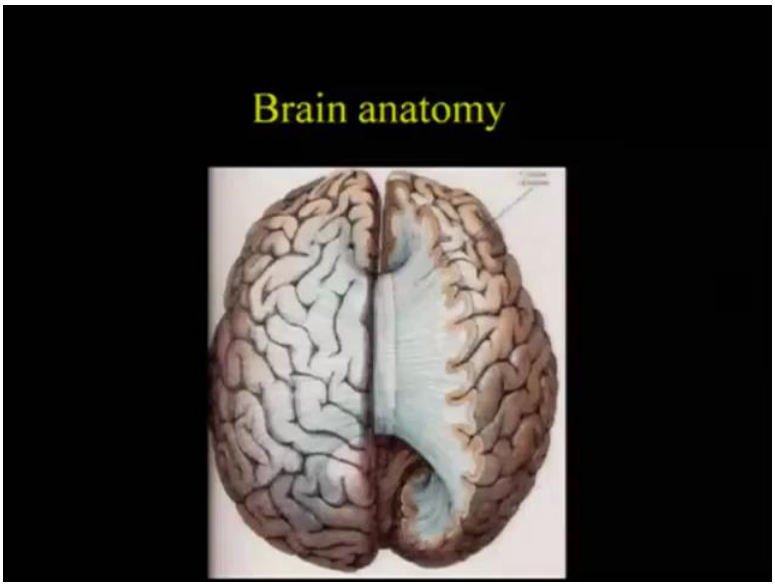

So, when I am talking about the brain, let me show you a picture of the brain. This is the brain broadly. So, you have a frontal lobe, you have a Parietal lobe, we have a temporal lobe, we have a occipital lobe and this structure is “Cerebellum” and you have 2 structures like this, this is from the below, but if you look at the brain, it has 2 half united which look alike divided united by this thing call Corpus Callosum, Corpus Callosum is like a band which goes between 2 half of the brain. You must have heard of right brain left brain they are different function assigned to it, which is partly a myth also artist have right brain better working and left brain and all that is a myth I think, but this is the Gross Anatomy of the brain it has definite lobes it has 2 halves.

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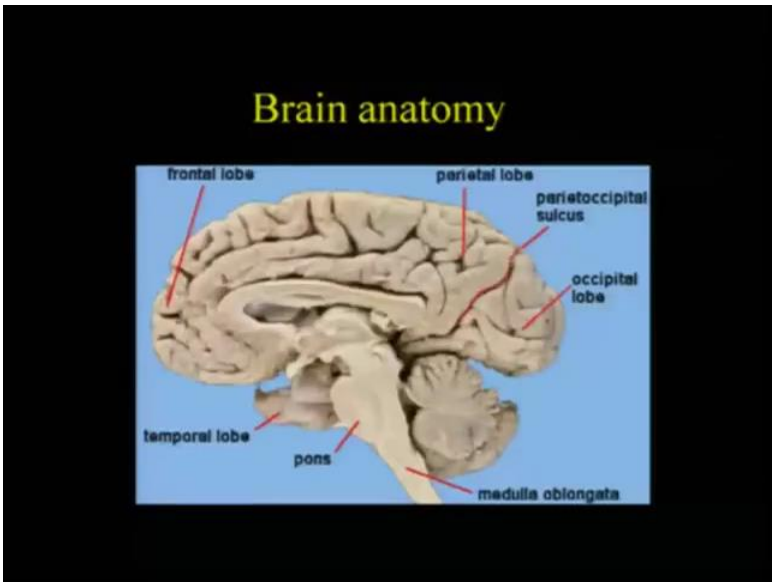

This is the brain it looks from inside again frontal lobe is front, temporal lobe is side parietal lobe is here, occipital lobe is behind. There is a structure calls “Cerebellum” which is important for movement and this is the pons and medulla oblongata, which controls respiration and heart and everything. And then it goes down to the Spinal cord. So, this is the gross brain anatomy.

I will stop at this and in the next lecture will continue this and see how all this turns into the functioning. So, we do not have to bother about anatomy too much, we got gross idea you can always read, but next time we look at the function.

Thank you.