Psychiatry an Overview
Dr. Alok Bajpai
Humanities and social science
Indian Institute of Technology, Kanpur

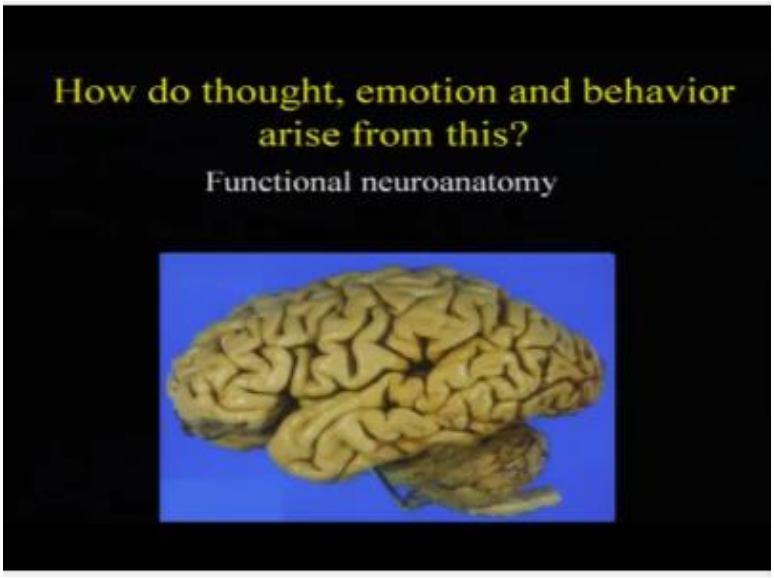
Module-01
Brain and Behaviour-Approaches
Lecture-01
Neuroanatomy

Good morning, welcome to this 10 hours course on psychiatry, an overview. We have tried to divide this course into four modules, and in the first week we will be focusing on the bases of human behaviour. But before we move on to the bases of human behaviour let us clear a confusion, in common public and lay people there is a whole lot of confusion between what is psychiatry and what is psychology.

To give you a brief definition, a psychiatry is a branch of medicine which is suppose and it does, deal with human behaviour and its abnormalities, essentially trying to understand the illnesses arising out of mind, the behavioral disorders, and attempts to treat it. So people do their medical graduation and then they specialize in psychiatry. Whereas psychology which is obviously a older discipline is a study of human behaviour in general.

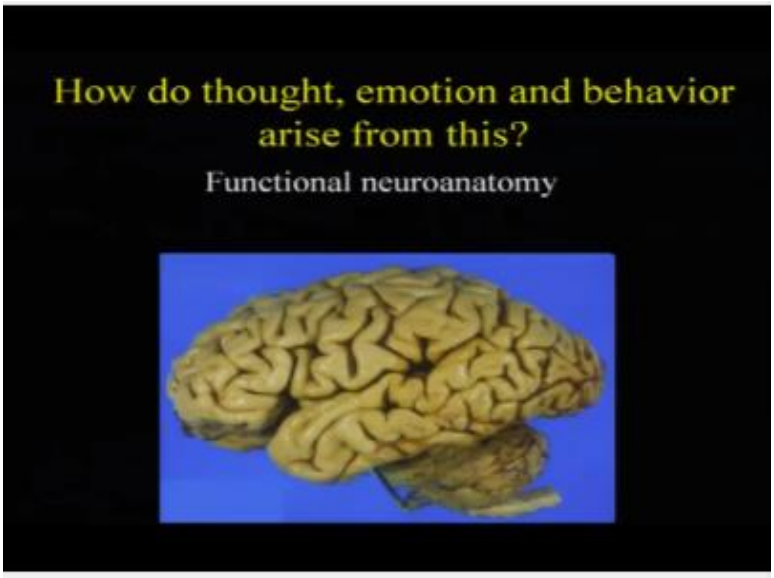
And its application and education, organization, various other psychological concepts of mind, we will discover these interface as we move on. Psychiatry also interfaces with other branches of medicine like neurology and general medicine and has its implication in that. But all that we will cover in the coming few weeks. For now we will try to understand why do human beings do what they do.

(Refer Slide Time: 02:01)



So this understanding of human behavior has a basic question.

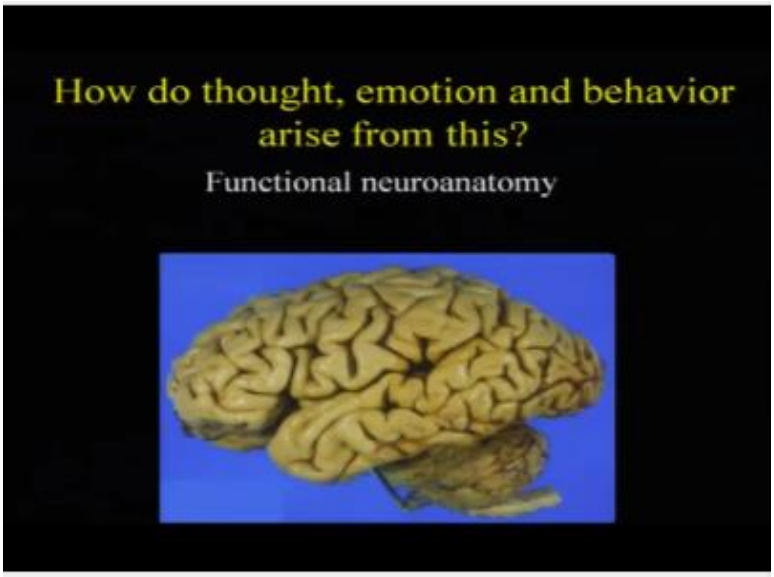
(Refer Slide Time: 02:15)



How do the thought, emotion, and behavior arise from this portion of our body called brain? As we go on in this four, five hour – two, three hours of lectures in this week lot of this is connected, because they all connect it to the human brain. So a lot of information may overlap or one lecture

may telescope into each other. So please try to understand it as a composite whole, there are no clear cut division in human behaviour and so as in the brain.

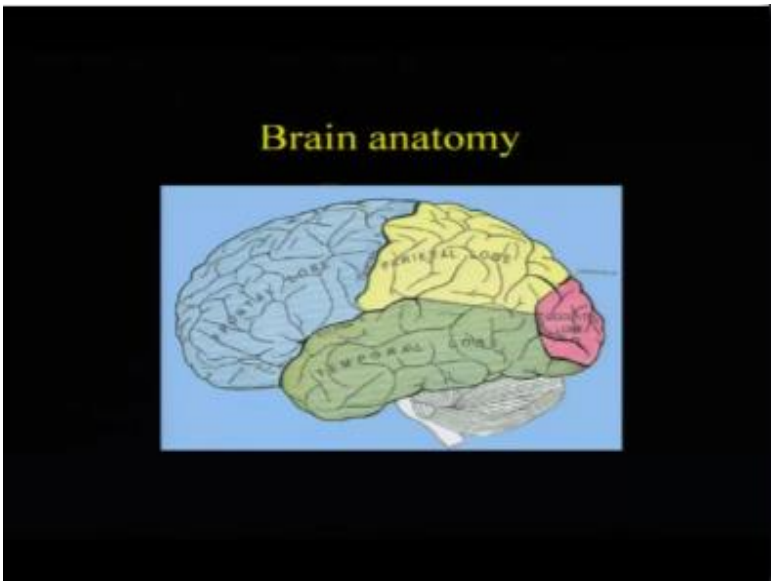
(Refer Slide Time: 02:52)



But to start from the basic, there is a structure of human body called brain is 1.3 kg of almost pinkish structure safely enclosed in your skull. But its activity creates you, it creates what we do, it creates all the human interaction, society and all that goes on with human life. For practical purposes and there is a confusion and there is a lot of philosophical debate on what is mind and what is brain.

But for our purpose all through this lecture we will use it interchangeably. And for a common understanding as a very, very simplistic statement, I would like to tell and – that mind is what the brain does. As the brain goes on with its functions mind is created, and mind is a composite whole of the behavior, the interactions, the feelings, the emotion. So let us go over this basic anatomy and physiology, both are interrelated in brain as history and geography both affect each other in a reciprocal function, so does the anatomy and physiology in human brain.

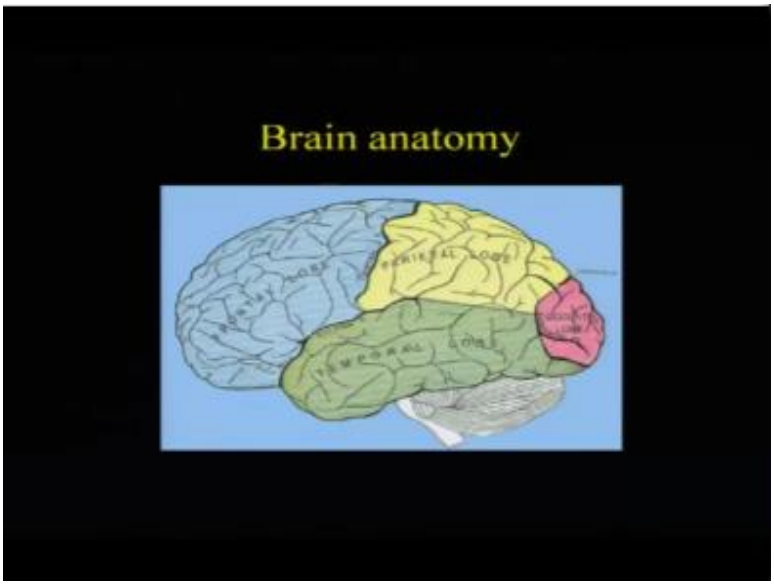
(Refer Slide Time: 04:22)



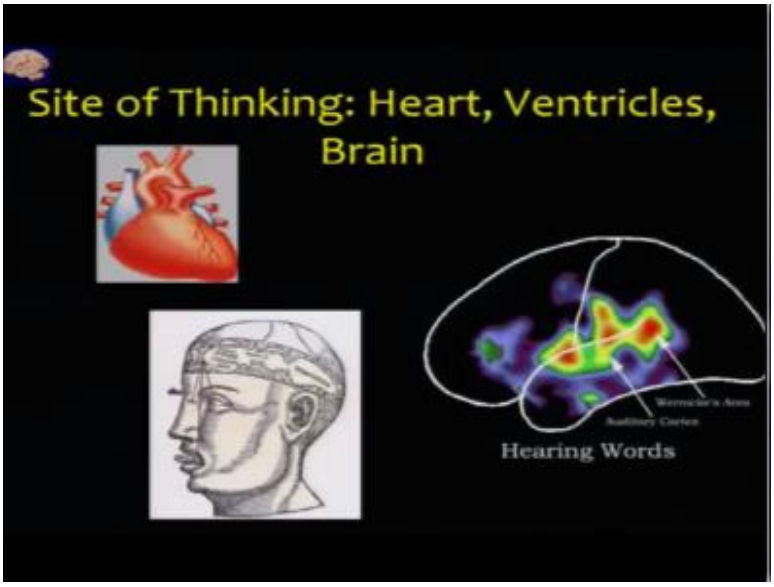
If you grossly look at the brain what you will find is its -- it has the front which is called a frontal lobe, the parietal lobe behind it, on the sides are temporal lobe, and there is a occipital lobe at the back. And tug in between is the midbrain and below it is the cerebellum, and this portion, this white portion which you see is the medulla which continues as the spine in a spinal cord which is safely tugged into the vertebral column.

They form the part of the spinal cord in the brain form a part of central nervous system. We will not be bothered too much about the spinal cord; we will focus on the brain, because that is what we are concerned within psychiatry. Although the peripheral systems are of interest to us, but mainly it is the behavior, so we will focus on the brain and as a part of central nervous system.

(Refer Slide Time: 05:18)



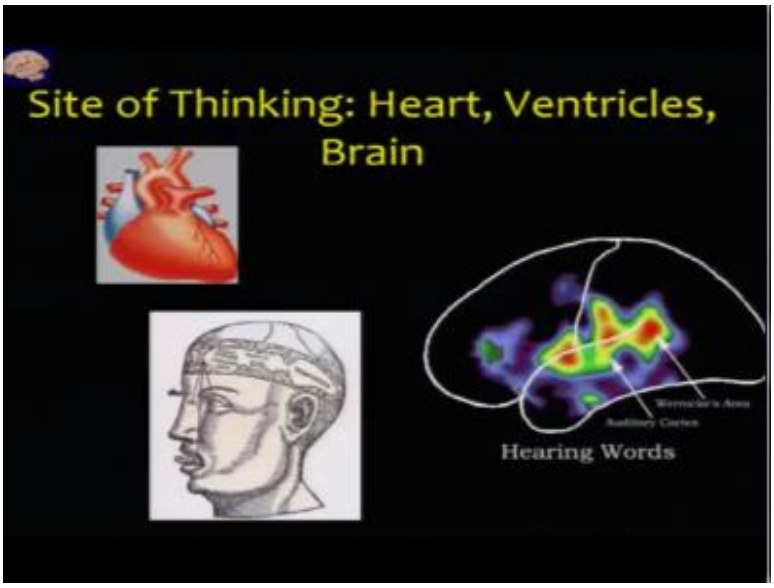
(Refer Slide Time: 05:20)



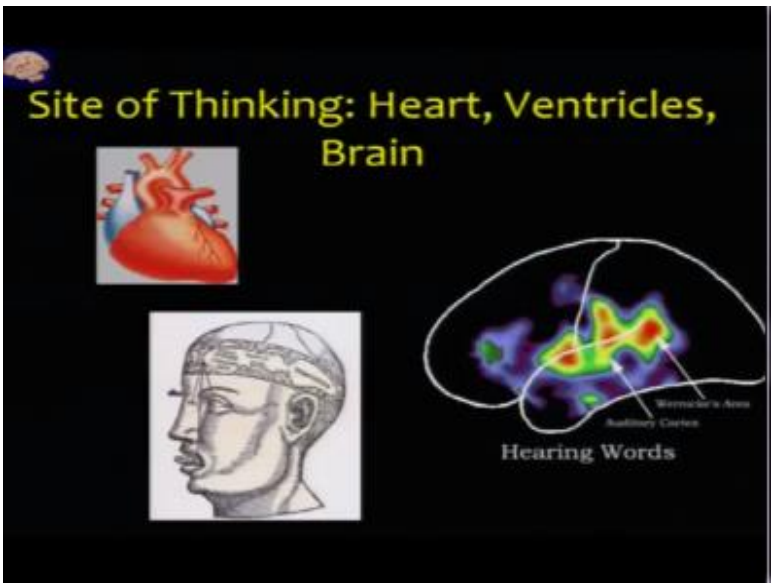
Let us go back to history, because we always – we did not know always that the brain is the seat of thinking. So there have been lot of philosophical mulling over this issue, initially it was thought like poets still think that the heart is the important thing. And so, because the emotions were always predominant and they are still predominant in most people, they form a major spine

of behaviour. So it was initially thought it is the heart which is the center of thinking. As thinking progressed then we evolved.

(Refer Slide Time: 06:00)

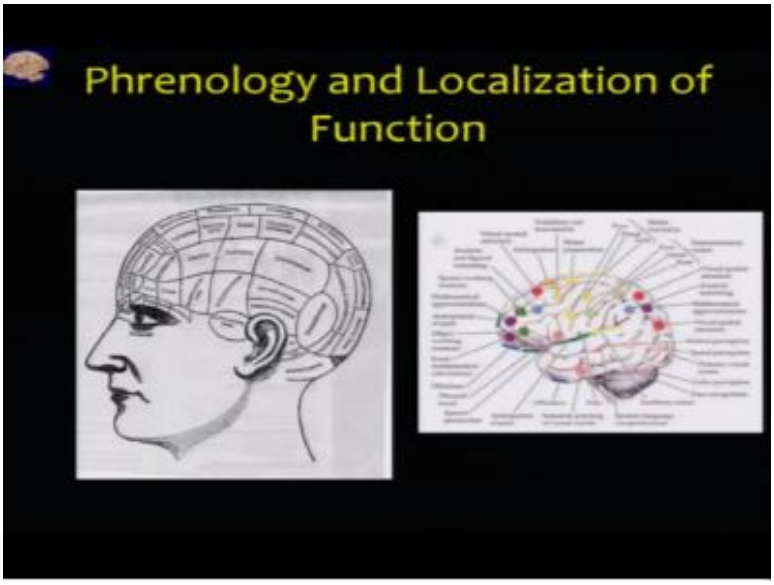


We thought it is the ventricles, those small areas in the brain which are the site of thinking. But now we are sufficiently sure that through advancement in knowledge, thought and technology.
(Refer Slide Time: 06:16)



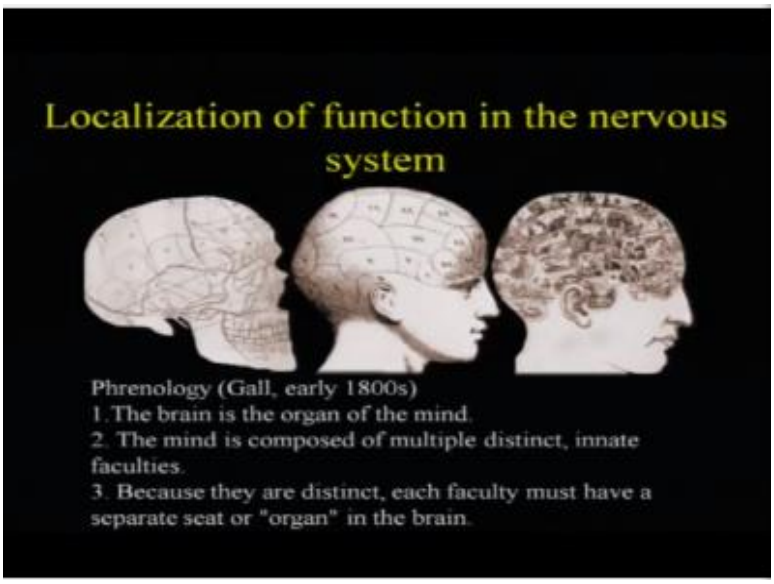
That it is the brain eventually which is the center of thinking and feeling. So heart may rule the poetry, but eventually the emotions also lie in the brain. This is one of the images promo functional MRI, and these are the areas which I demark it; we will talk about functional MRI later where this is the area where we hear words, just for your preliminary introduction.

(Refer Slide Time: 06:40)



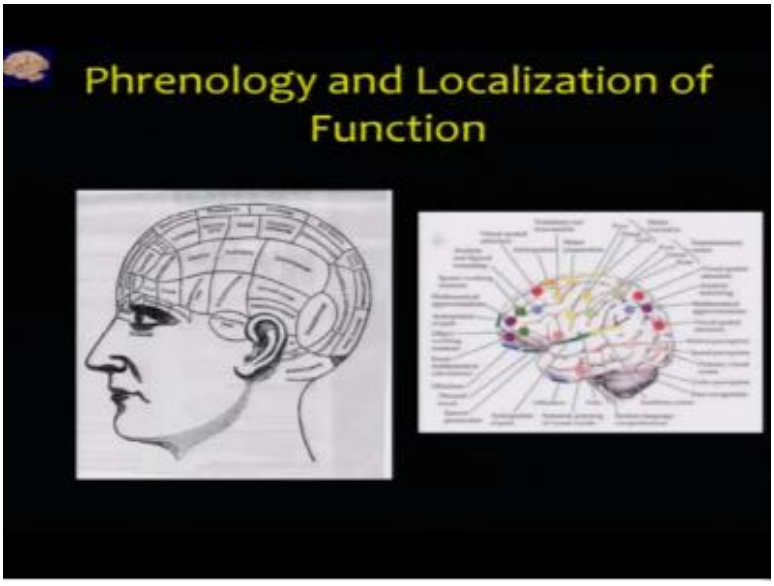
What really got a Philip and an impetus to thinking was there something called phrenology which is no more considered as a science.

(Refer Slide Time: 06:53)



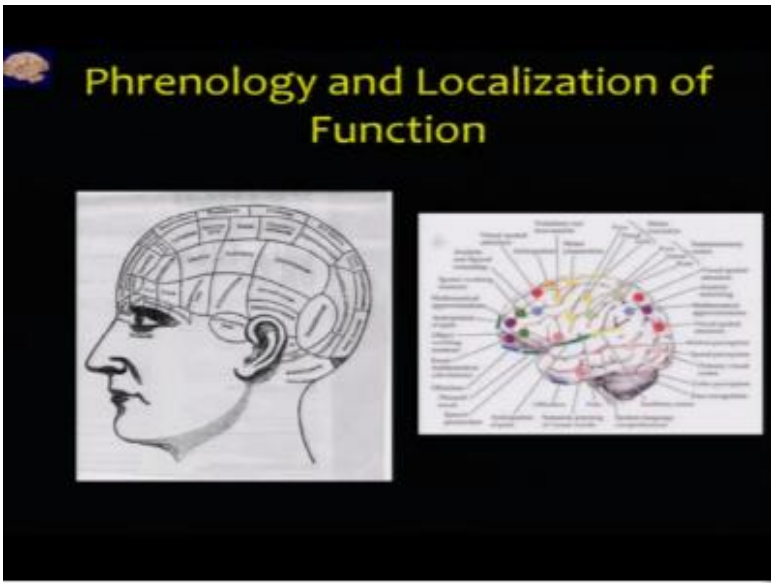
But phrenology was brought by a person called Gall in early 1800s and he emphasized that the brain is the organ of the mind, it is composed of multiple distinct, innate faculties. And because they are distinct each one of them, each faculty must have a separate seat, so what I was essentially saying that each behaviour or a component of behaviour has a separate seat and they really wanted to check all this through the bumps on the forehead right. This at that time probably became very popular, but it is no more considered as a sign.

(Refer Slide Time: 07:30)



But to give the devil its share it may not be the bumps on the forehead which maybe telling this, but more or less through the modern technology and by the various tools of studying brain.

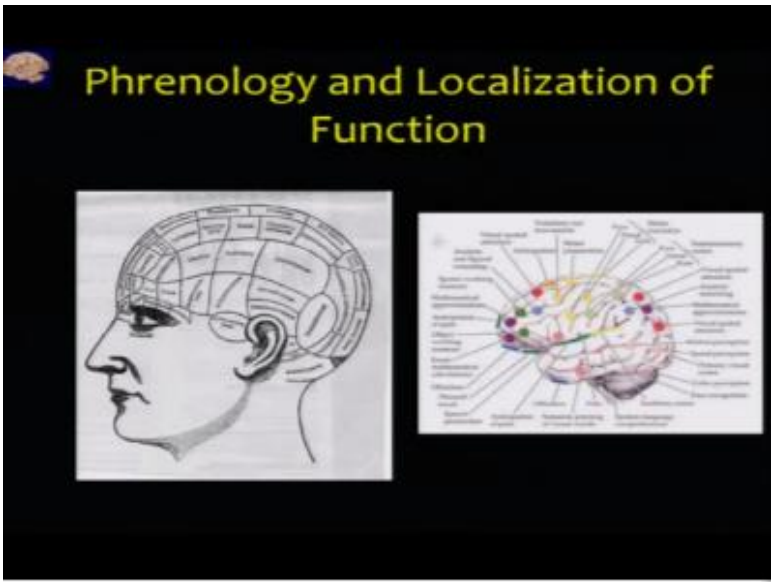
(Refer Slide Time: 07:43)



We have this accumulated this knowledge over years where we can demarcate grossly the areas from which the functions are regulated. For example if you see this area yellow area where it is for the motor preparation, like this area in the frontal cortex is for the anticipation. This area is for hearing mathematical calculations, and this underlying area is for smelling, this area is for vision, the movement, the shape of the objects and so on so forth.

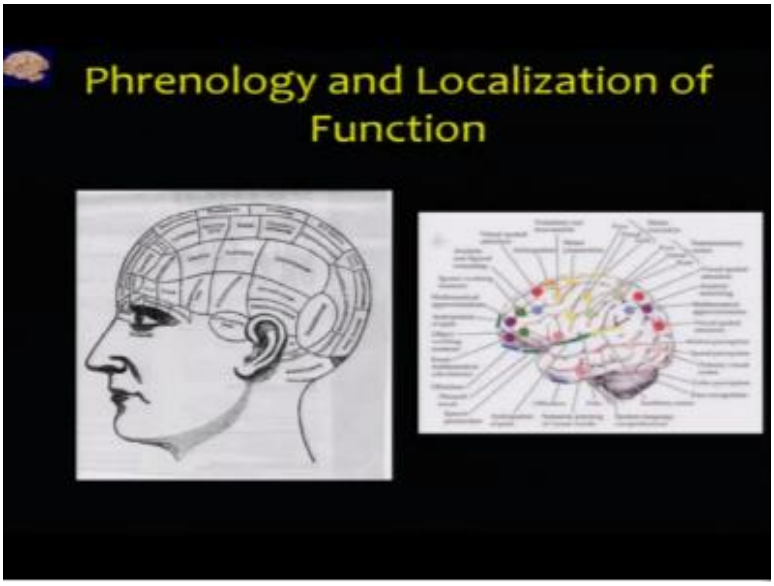
If we look at this area, if we divide it from in between the areas in the front is responsible for movement, the area behind it in the parietal lobe is responsible for perceiving, for the sensations, pain, temperature, touch.

(Refer Slide Time: 08:38)



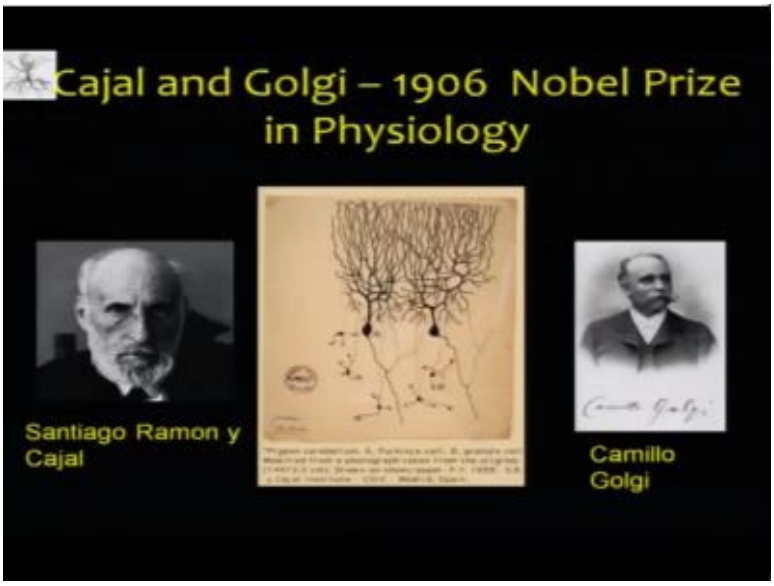
And the whole body is represented in this parietal area with foot on the top having the maximum area of representation and then so on so forth. So any peripheral sensation which arises from the body goes through the nerves to this area where it is integrated in perception and the signal is passed, we will discover this as we talk about physiology. And the brain decides to act on it and sends a signal to the spinal cord, obviously modulated by cerebellum and other areas to respond to it. That is what happens in a reflex action. So if you suddenly touch a hot thing your hand recedes back.

(Refer Slide Time: 09:30)



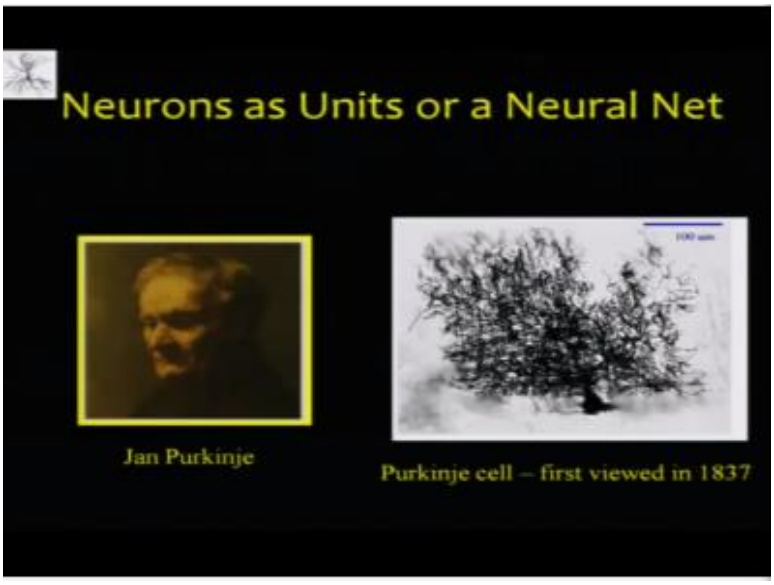
So within that milliseconds hundred or milliseconds the signal goes to the parietal lobe, the heat is felt here, the signal is passed, and the brain directs the hand to recede. So phrenology may not be true, but at least in some way or the other within the brain with technology we know that there are certain areas which are specialized for certain functions.

(Refer Slide Time: 09:56)



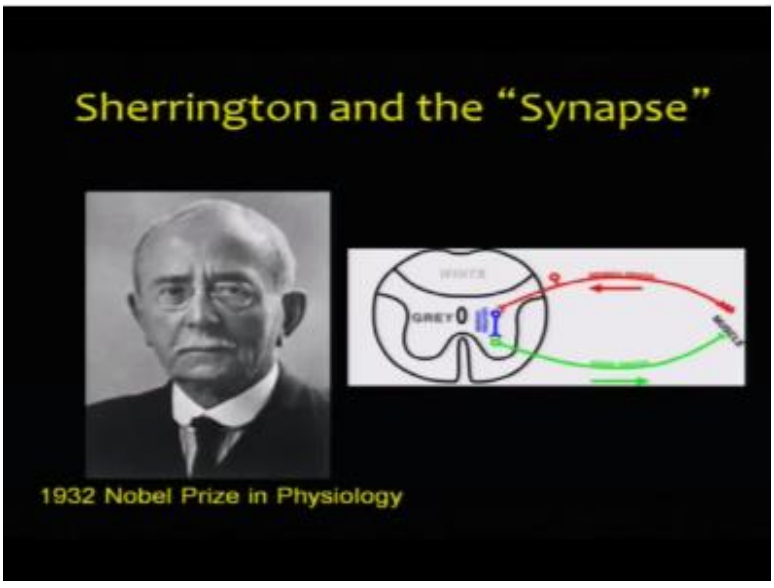
The micro structure of the brain was really discovered by these two people Cajal and Golgi where they discovered that the brain is really made of these fibers like things which form a network.

(Refer Slide Time: 10:09)



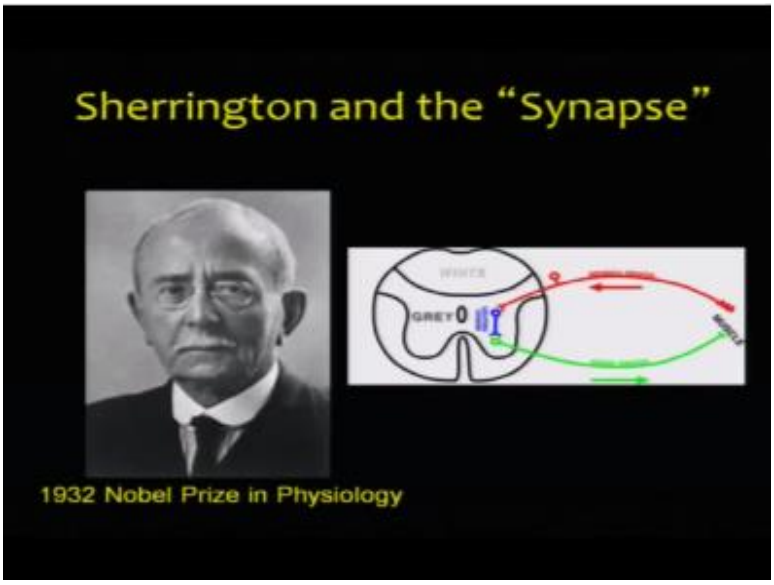
So neurons are the units which form the neural network, Purkinje, Cajal, Golgi they formulated it.

(Refer Slide Time: 10:20)



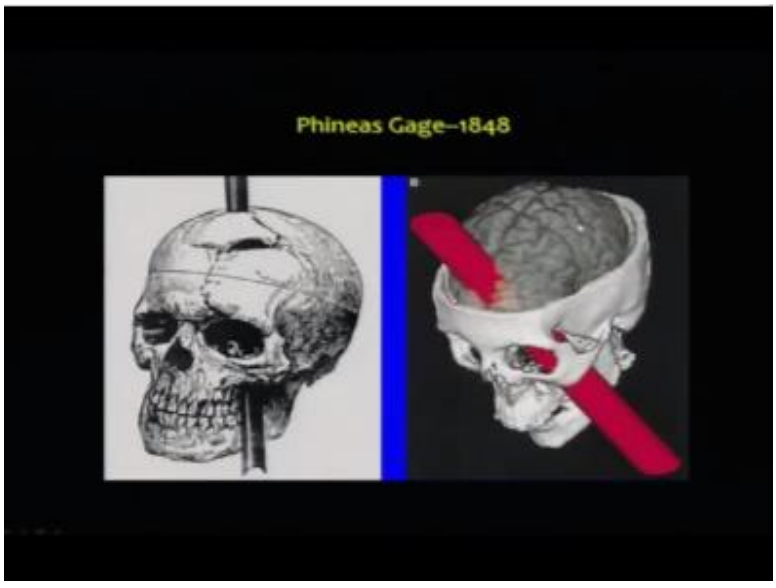
The further discovery went on that, how are these neurons connected? Neurons are like fibers, they are like cables which are running in the brain, and in the magnitude of 10^{10} or 10^{11}, and they are connected to each other through something called synapse.

(Refer Slide Time: 10:38)



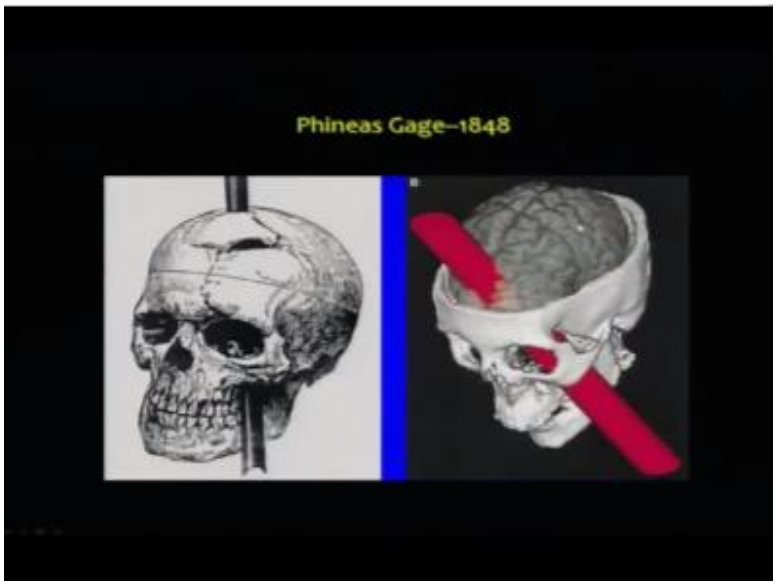
We will discover this synapse as we move on.

(Refer Slide Time: 10:40)



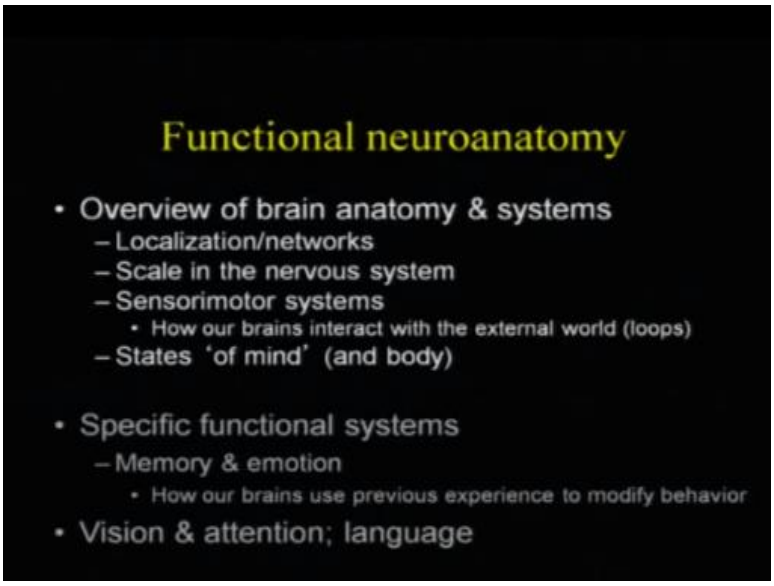
This guy, Phineas Gage was a person who has had a injury with some solid iron rod, he survived, it just pierced through his left frontal lobe and what was found, what was found that his behaviour dramatically changed, dramatically changed after this injury.

(Refer Slide Time: 11:02)



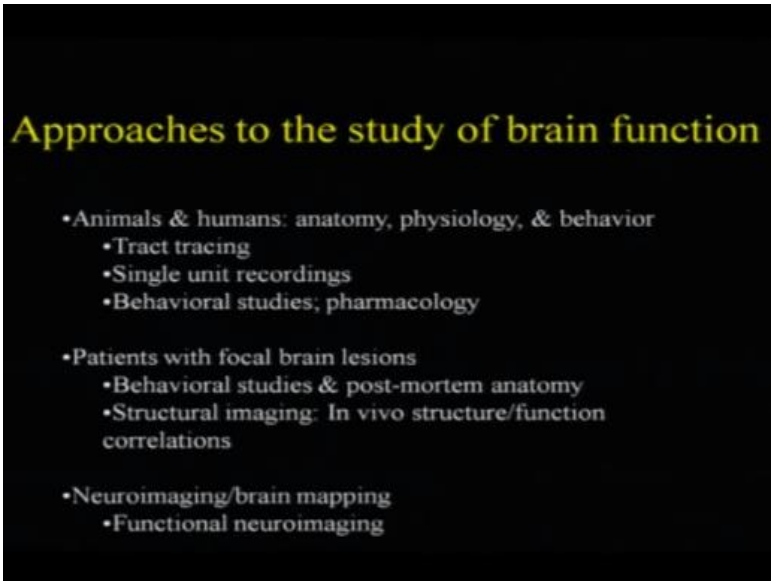
That was one more idea which came to the researchers at that time, that a injury to the brain can change your behaviour and using your reverse logic it was inferred that maybe this certain behavior which was happing before the injury is controlled by that area. Now this, this became one of the ways of the studying the brain so now if I go back and see how do we study.

(Refer Slide Time: 11:32)



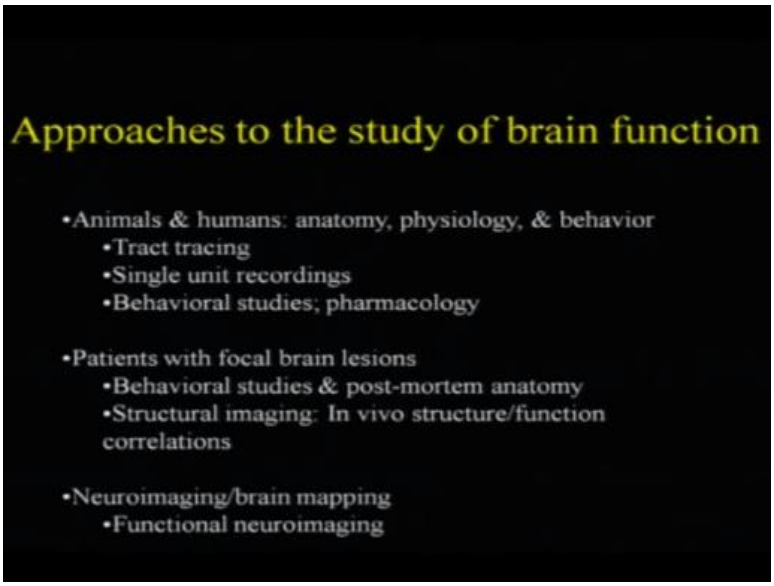
What are the approaches? So the approaches to study the brain

(Refer Slide Time: 11:36)



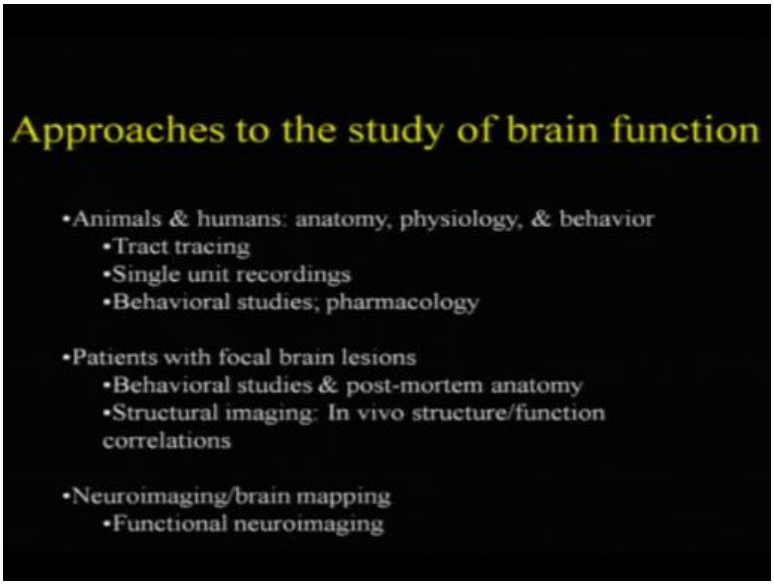
Are like anatomy, physiology where we trace the track, we do single unit recordings. Behavioral studies was a part of psychology, patients with brain lesions, people who have damage to the brain by illness or by injury.

(Refer Slide Time: 11:55)



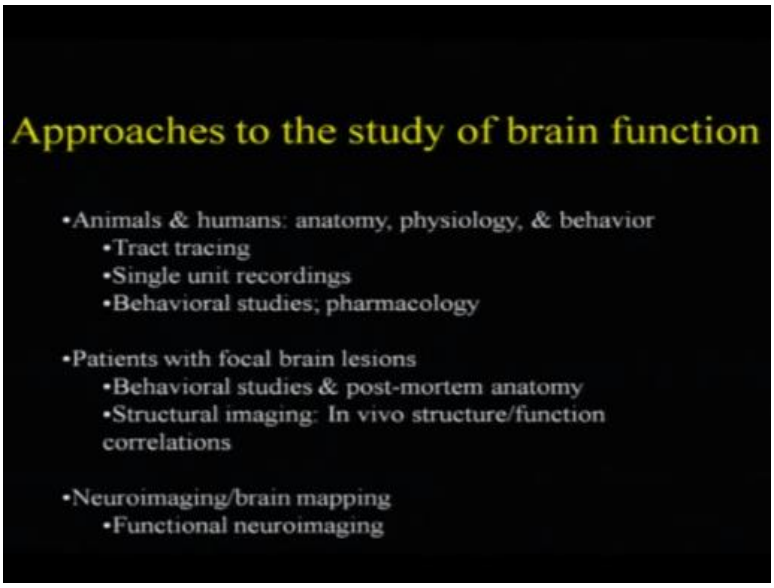
The behavioral changes which they undergo are correlated with the sight of injury and the difference in function it gives rise to. Postmortem anatomy, this was one of the very popular ways that

(Refer Slide Time: 12:08)



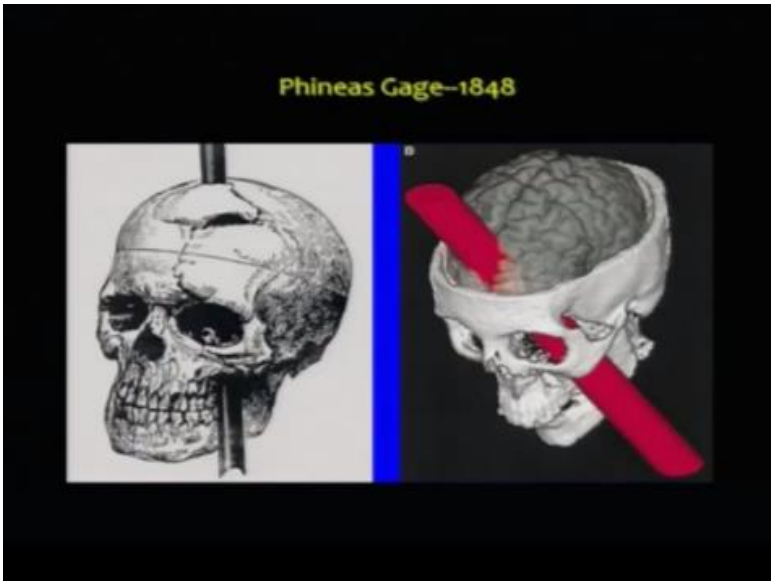
Obviously we cannot go into a live brain very deep and so once we do postmortem and then correlate what was happening during their life time gave us a idea of what was happening.

(Refer Slide Time: 12:20)



The structural imaging which is a new technology we will be talking be about later, and neuro imaging and brain mapping.

(Refer Slide Time: 12:28)



So in the last 40 years we have learnt about brain more than what we did in the last 3000 years all due to technology, but this technology is also based on what behavioral observations and anatomical lesion studies were done in the last 6, 60, 70 years of between 1900 and till late. Penfield, Penfield was a surgeon.

(Refer Slide Time: 12:56)

Who could find out areas of brain leading to certain functions, motor function or sensory functions, by stimulating those areas. During neurosurgery he used to stimulate certain areas and see what was happening in the body, either the blimps were moving or certain sensations were felt, this gave a huge.

(Refer Slide Time: 13:20)

It actually opened a wide window of understanding the brain.

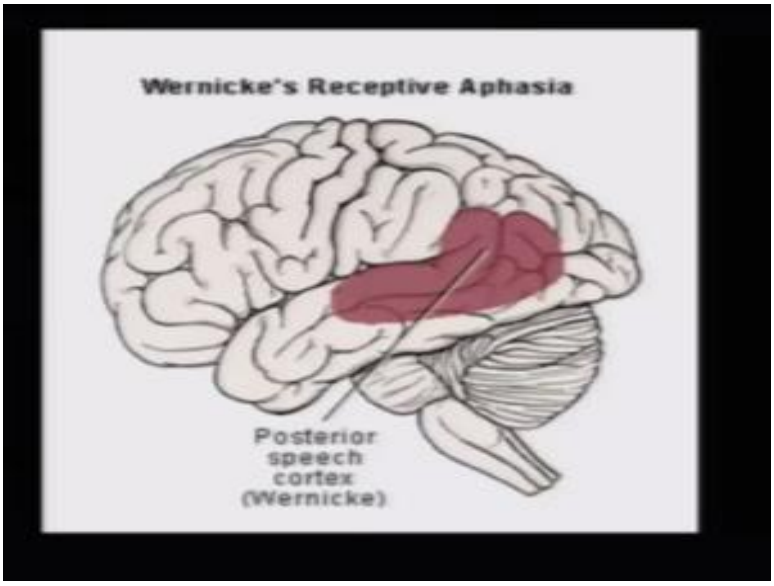
(Refer Slide Time: 13:23)

In localizing of functions along with Penfield Paul Broca, when he studied the brain of few people who had lost language and speech after stroke he found out this Broca's.

(Refer Slide Time: 13:42)

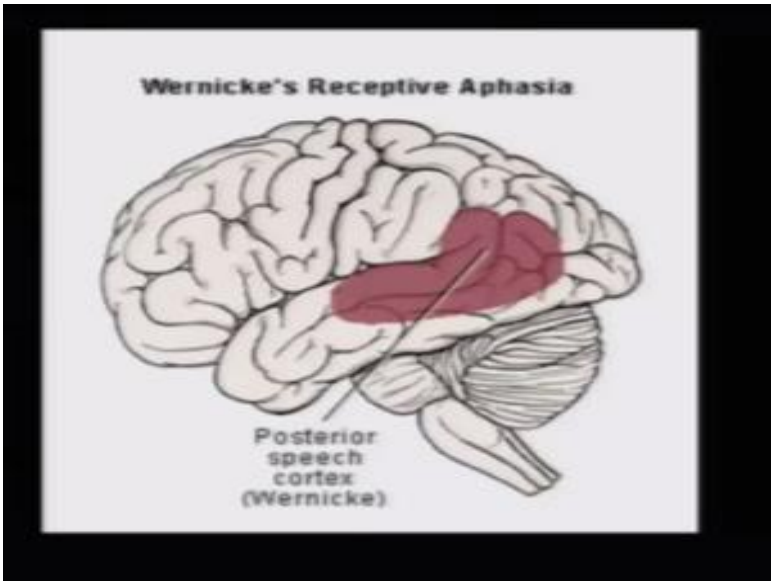
Areas which is on the left side tucked in the left side of the frontal lobe in the dominant hemisphere, so what was discovered that language area is in the left hemisphere, in most right handed people it is the left area and one thing which also came out with research was that the left area controls the right motored area of the body and the right brain, right side of the brain controls the left side. And languages are function in most people is in the left dominant hemisphere in the frontal lobe, almost following it was the people who were able to speak but were not able to comprehend the language and Wernicke's receptive aphasia is a term used for it which is in the temporal lobe.

(Refer Slide Time: 14:35)



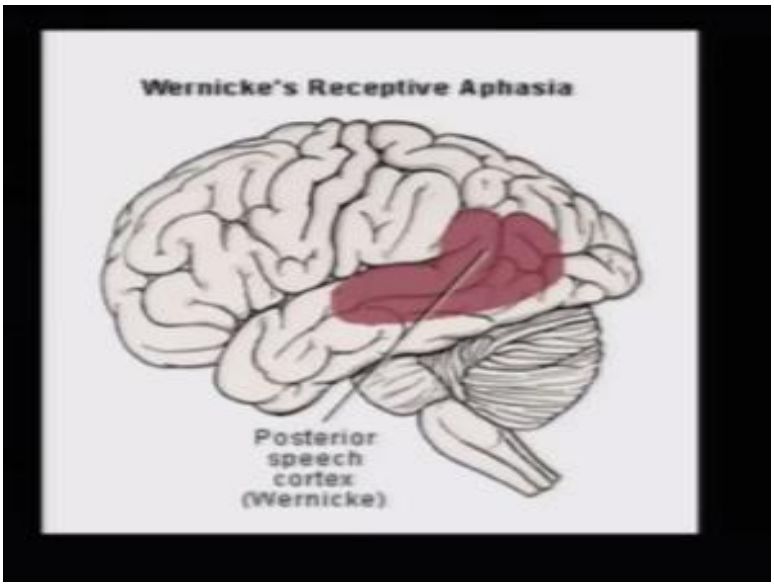
So now when we knew that in the frontal lobe damage causes Broca's aphasia where people are not able to express in language in the side of the temporal lobe.

(Refer Slide Time: 14:48)



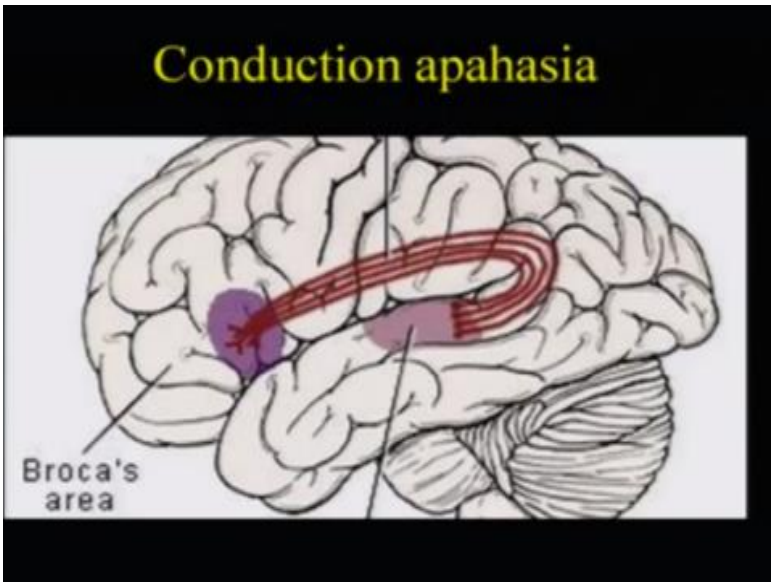
People here if you have damage by a stroke or by tumor or injury, people are unable to comprehend speech but this was still not clear. That why these two separate areas.

(Refer Slide Time: 15:05)



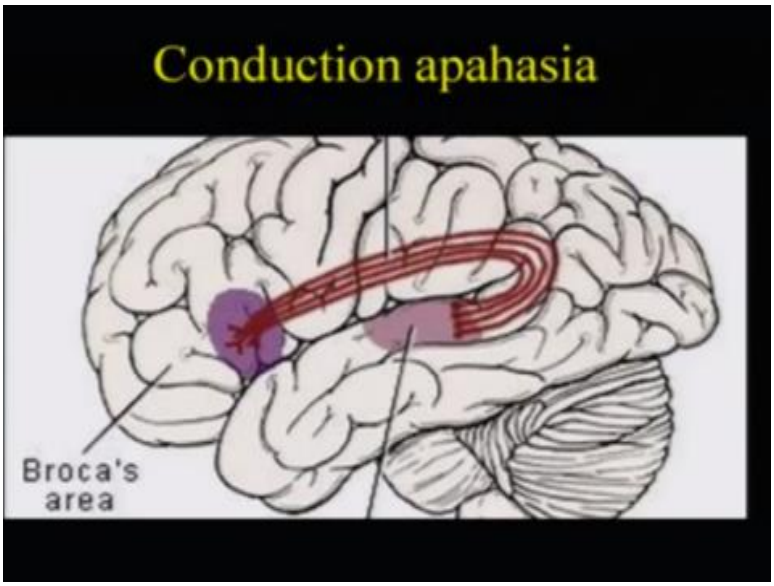
How do they connect, how does the speech connect, so the third big

(Refer Slide Time: 15:09)



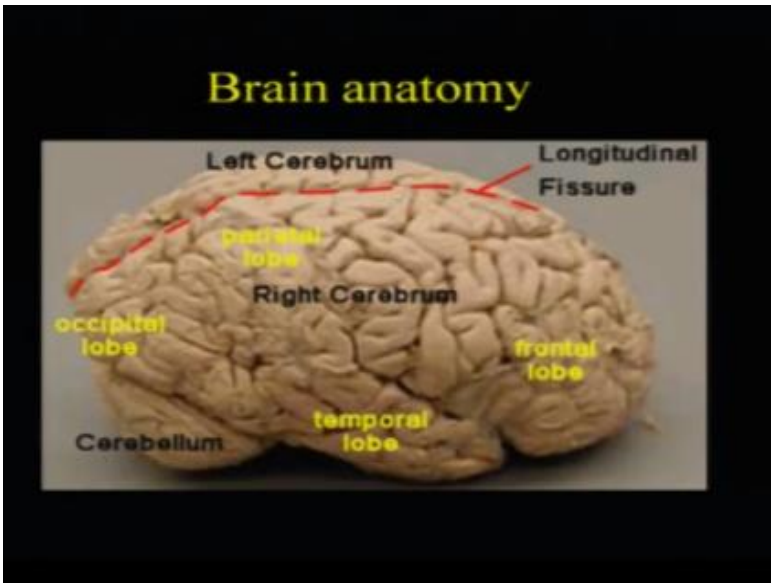
Thing was something called discovery of a conduction aphasia. Where Borca's area was intact, the Wernicke's area was intact but in-between the damage caused condition aphasia. The person could express, the person could hear, but could not relate the two sinks, this gave the idea

(Refer Slide Time: 15:31)



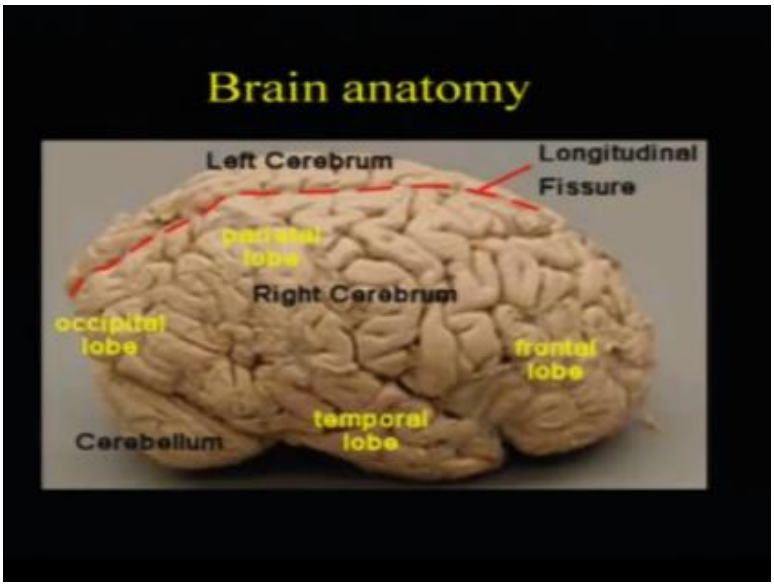
That brain may actually be working in a network.

(Refer Slide Time: 15:35)



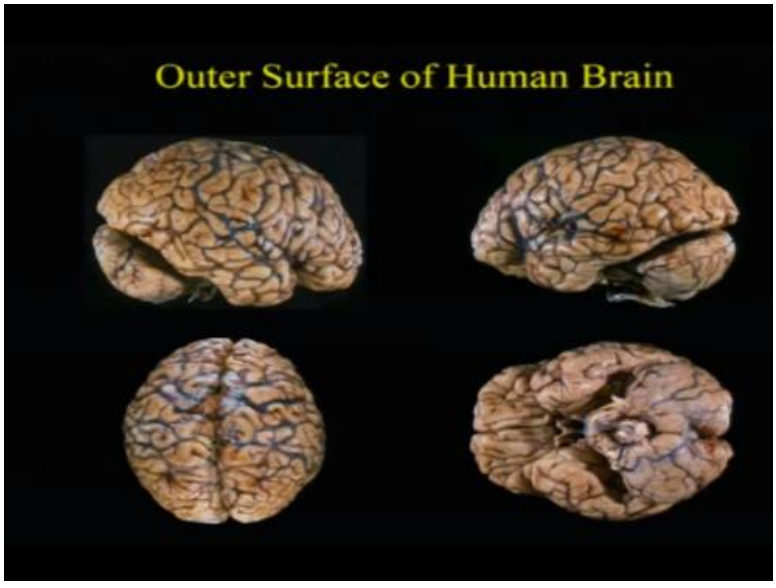
We will discover those network as we talk, again to just to

(Refer Slide Time: 15:39)



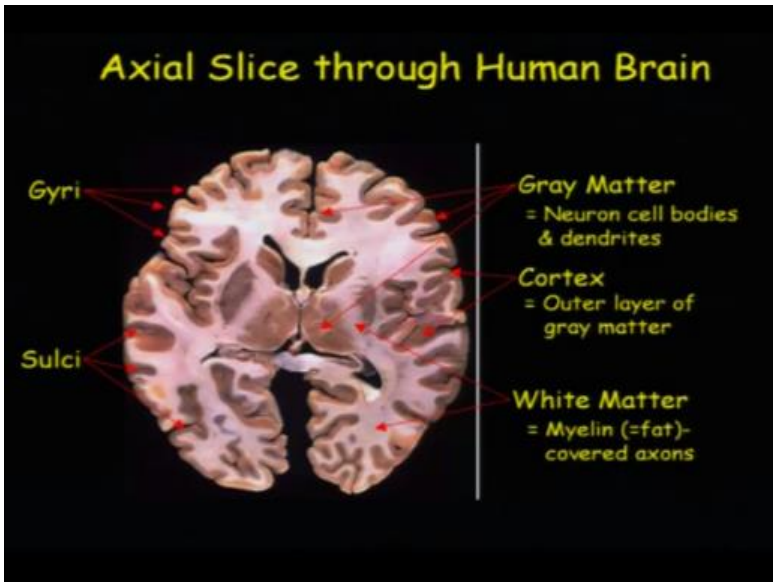
Revise it this is the gross structure of brain frontal lobe where I said on the left side is Broca's area, temporal lobe this area is Wernicke's where you here, parietal lobe is all sensations go in here, this area controls the motor movement, and occipital lobe is for version, cerebellum is for fine tuning of motor movements, of body movements.

(Refer Slide Time: 167:01)



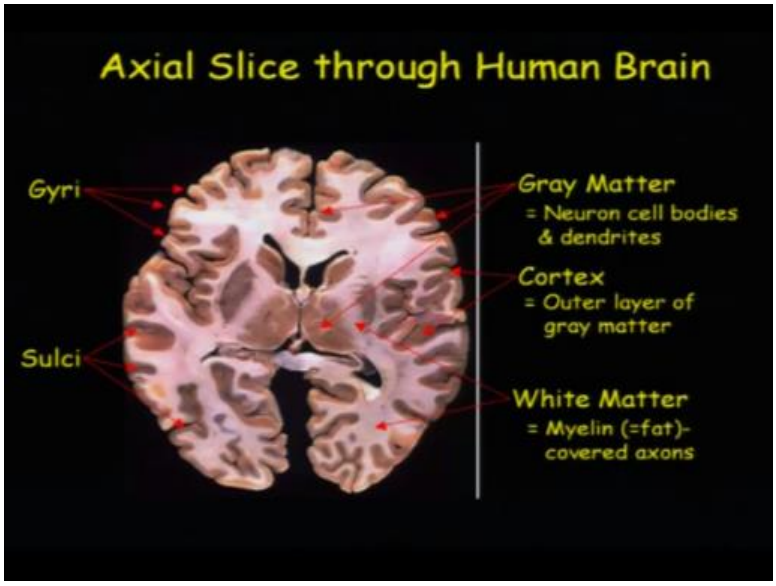
So this how the brain looks like.

(Refer Slide Time: 16:04)



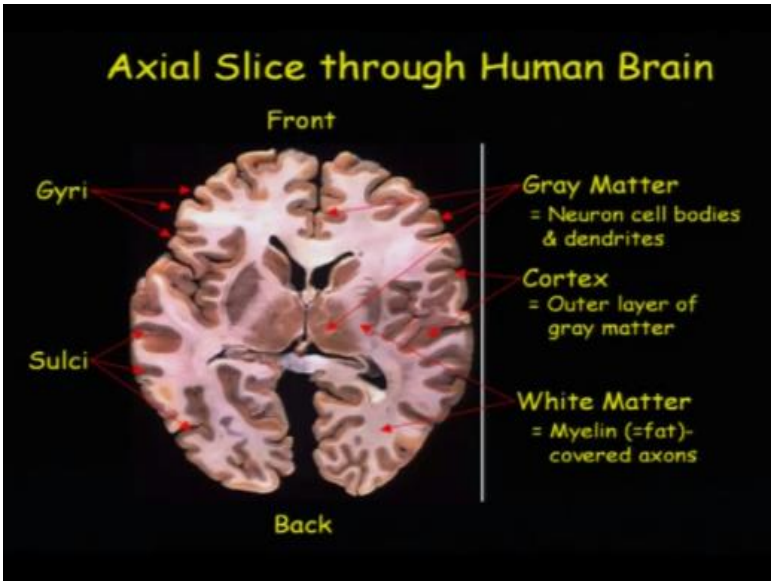
And if you cut the brain we will, it is something like this. This is the cortex what we call we all have heard of gray matter and white matter, this colored area is all gray matter, actually it is not gray human live brain looks pink, and this is all white matter. This white matter forms the nerves actually the neurons it comes down, so all this if you look at this the gray matter is composed of neuron cell bodies and some braches coming out of it call dendrites.

(Refer Slide Time: 16:42)

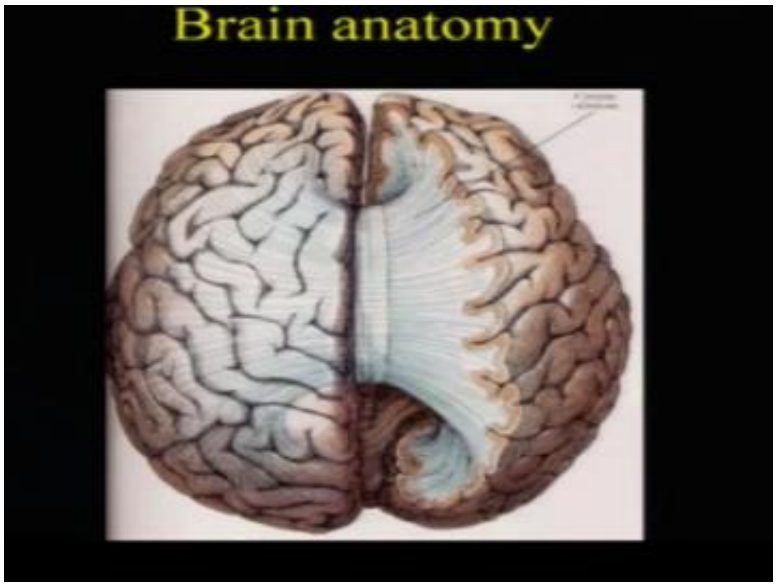


And this is the cortex, it is a six layer structure which covers the whole brain. White matter, these nerves are covered with additional sheet of fat and which come down and carry the signal to different areas of brain and down to the spinal cord. This area is the mid brain so we have a outer layer of cortex divided into frontal and parietal and temporal. Within this cortical layers is stuck the deep areas of brain, if we keep slicing we will see different things. This is all basal ganglia which are form of a part of mid brain.

(Refer Slide Time: 17:27)



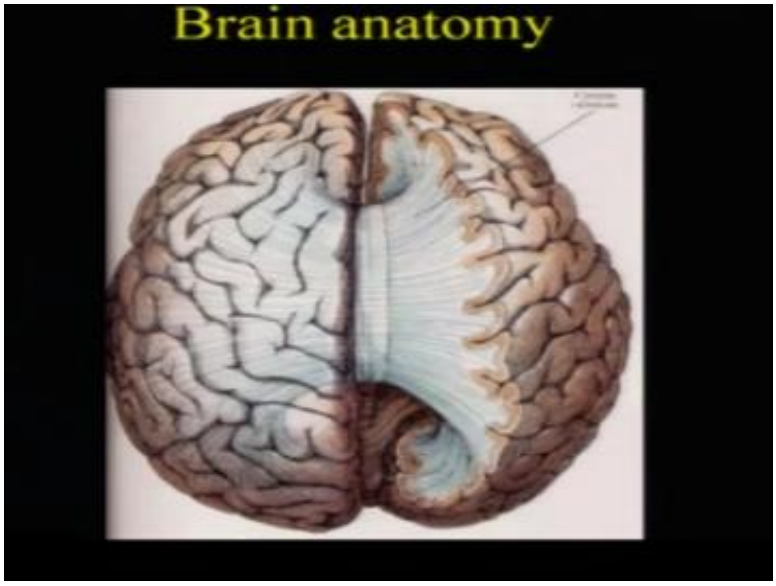
(Refer Slide Time: 17:28)



So brain is also not just not a composite one single structure, it also is divided into two hemisphere, so if you look at it now we have a brain which developed in the last millions of years after we diverted from chimpanzees, the brain has evolved to have a older structure which is responsible for movement which is present in lower species of animal also, it has a structure call mid brain which came somewhere in between during evolution and the neo-cortex we have so we have a paleo-cortex, we have archi-cortex and we have a neo-cortex.

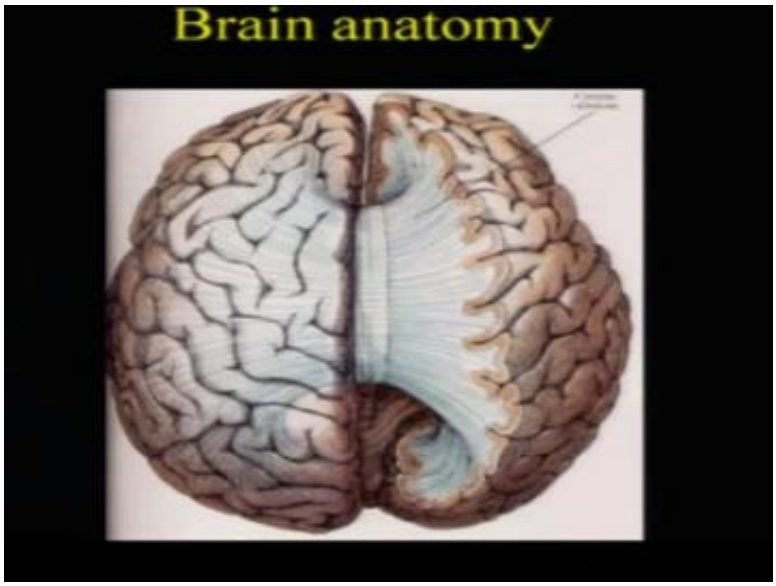
The neo-cortex is the latest structure which evolved which is responsible for our thinking and all the complexity of human brain, so brain

(Refer Slide Time: 18:17)



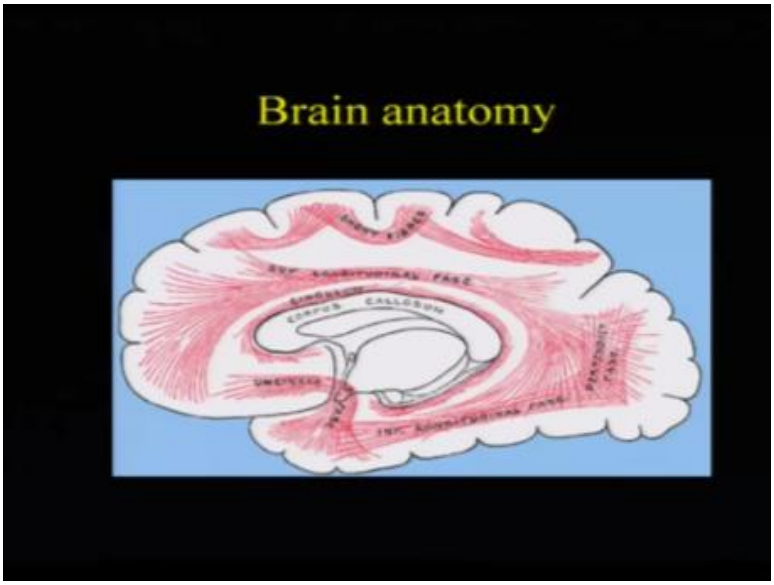
Has two hemispheres, cerebella hemispheres, left and right, you would have heard of right binded and right brain and left brain, they are, this is a partly as we have understood the behavior and its areas which control the brain, control the behavior into, they are specialized into some of them are well done by left and some by right, but they do not function independently though they have independent function but they are connected by.

(Refer Slide Time: 18:59)



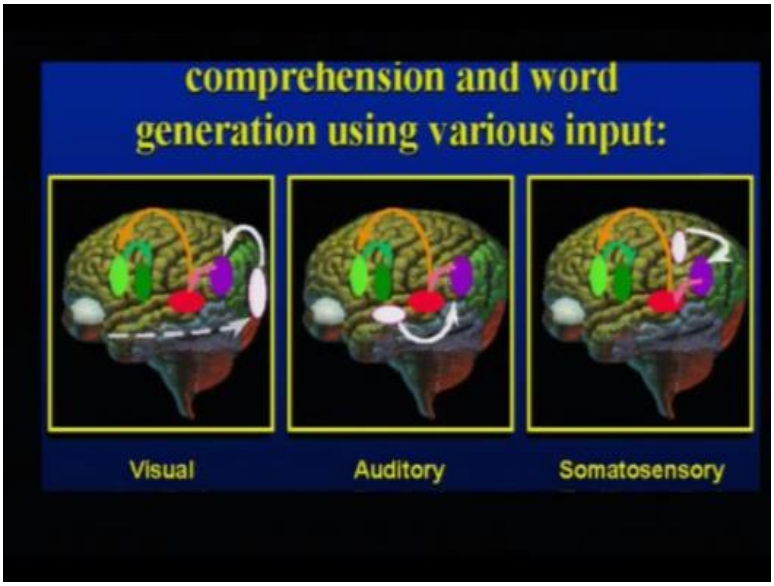
This structure called corpus callosum, this whole corpus callosum is a structure which if you can see this arrow it is here, it has maximum number of neurons and connects both the hemispheres. It goes on like this, the cortex of both the hemisphere is connected so brain is actually taking in information, integrating it between two hemispheres and leading to some action on it, so if you cut if you cut the brain

(Refer Slide Time: 19:30)



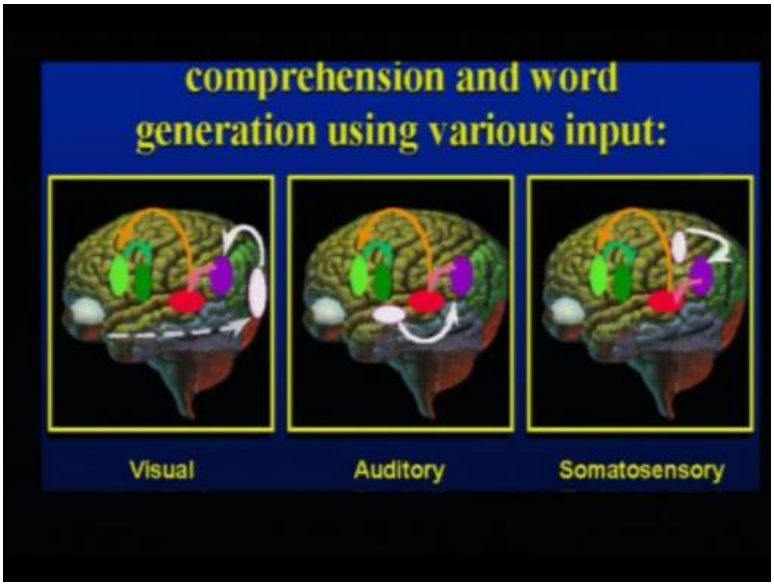
If you cut the brain from the side from between the two hemispheres you will this is the type of networks and fibers which you will see, so this is within one cerebral hemisphere so it is connected from front to back, up to down, and with corpus callosum between the hemispheres.

(Refer Slide Time: 19:49)



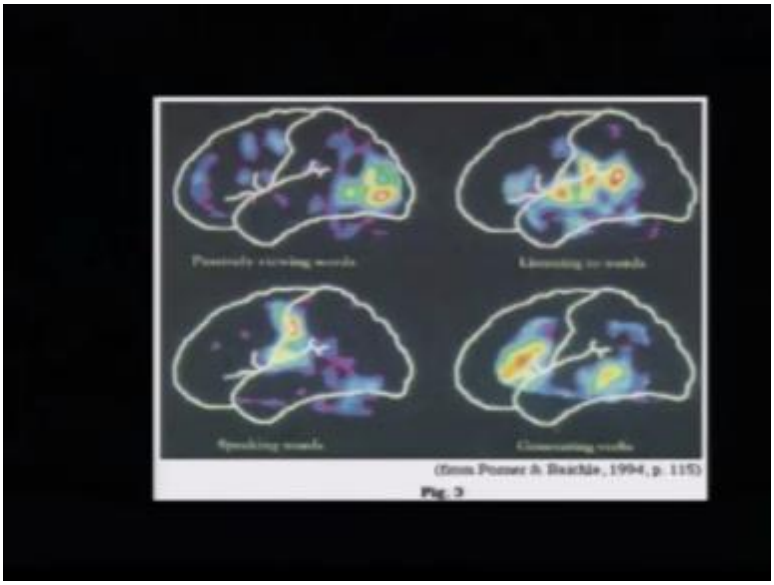
This is just a broad gross thing to show you how we comprehend and we generate the words using various inputs right, so like it take this visual thing, from here the sensations go, the word go here and is the frontal lobe which gives a meaning to it. Auditory it goes to the temporal lobe and it goes to the frontal area where the meaning is given to it, here it is like a somatosensory, touch is given meaning to this, so they are as I said the temporal lobe in a very, very gross terms is a temporal lobe where you hear, parietal lobe you feel, and occipital where you see, but all this information actually is circulated through the network and it is a frontal lobe where the meaning is given to it.

(Refer Slide Time: 20:42)



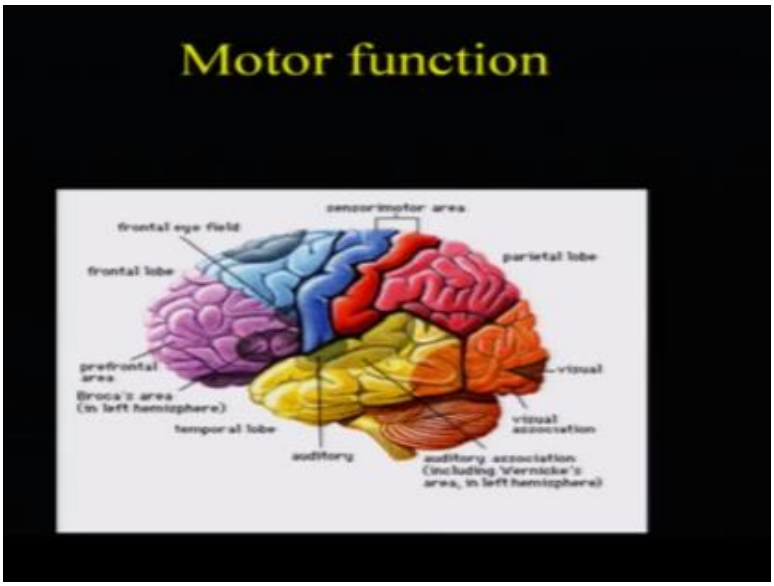
We will discover this as we go around the studying the physiology.

(Refer Slide Time: 20:46)



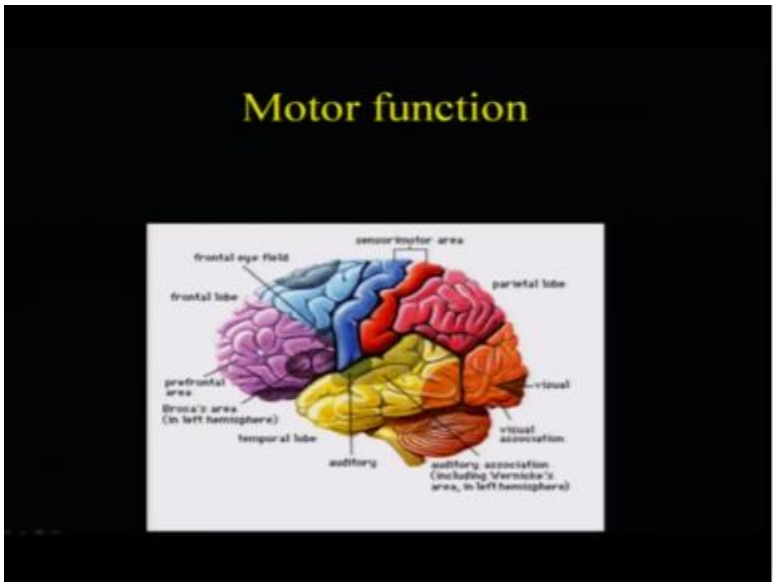
This again as I said this is, these are the images from functional MRI, this is a passively viewing words when you are just seeing the word and not thinking about it, even your listening to the word is a temporal area again, when you are speaking these areas get active and this is what you are generating words, generating words in the frontal lobe.

(Refer Slide Time: 21:11)



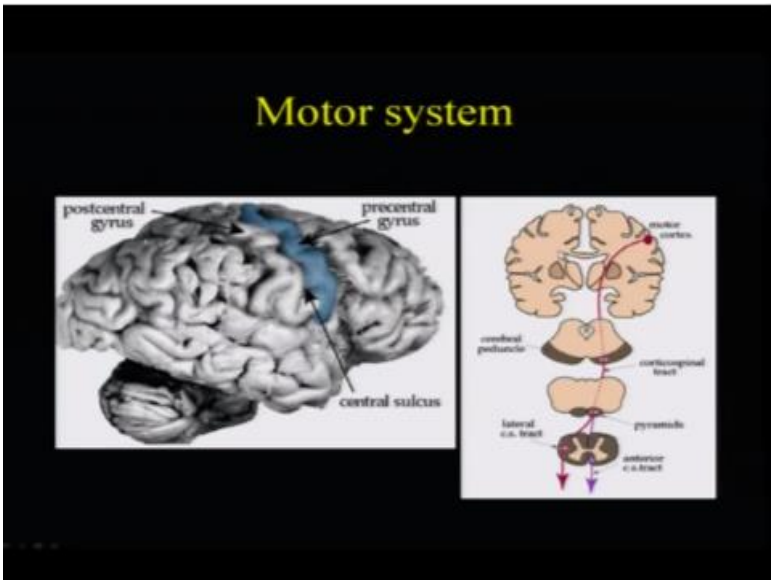
Now as I said if you see the broadly, this is a sensory motor area there is a cut in between, here the sensations come, foot is on the top and rest of the areas. This information here the words come here it is a visual thing, there are also these type these areas are present in all the primates, but why human brain is different is with the development of association areas, association areas are more specialized area which are used to coordinate and integrate information like this is auditory association area in addition to the area where you listen word this gives meaning to it, and this includes a Wernicke's areas like you find the frontal lobe where words are generated Broca's areas, but this also this is a frontal area we also have pre frontal area, pre-frontal area is considerd to be the chief executive where decisions are make, pre-frontal area assesses on what action to be taken, the salient's of the importance of the stimulus which comes.

(Refer Slide Time: 22:20)



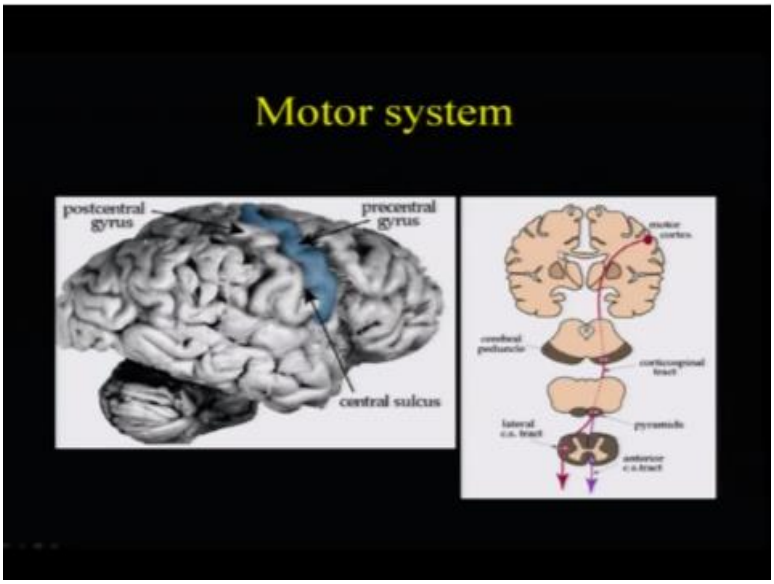
We will talk about these networks as we move on.

(Refer Slide Time: 22:24)



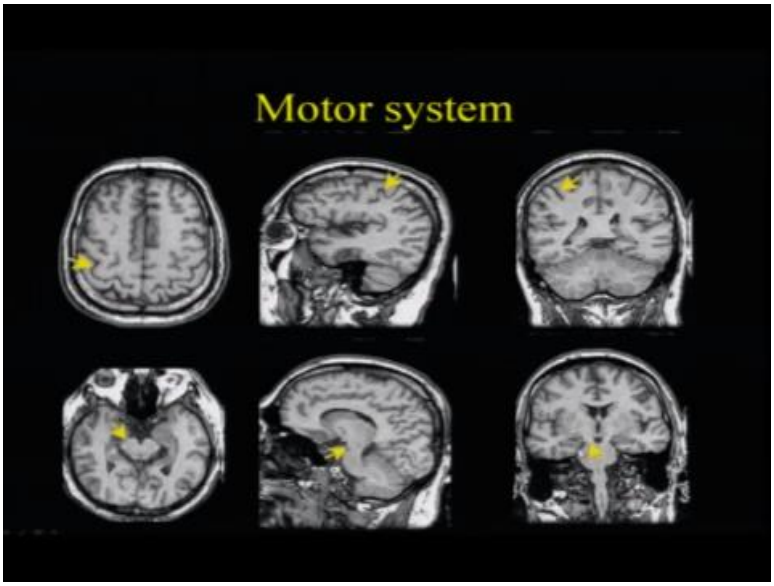
So as, so this is a, it is like a precentral gyrus, if you see this cortex you can see lot of these folds so this, the valley between the folds is called sulci, sulcus and this folds are called gyri, if you see it here it goes like this, so almost appears as a fractal geometry, these is called gyri and this is called a sulci this is how, this is a very smart trick of nature to increase the brain area, to fit in 10^{10} neurons, otherwise if you spread them you can imagine how much space it would take.

(Refer Slide Time: 23:00)



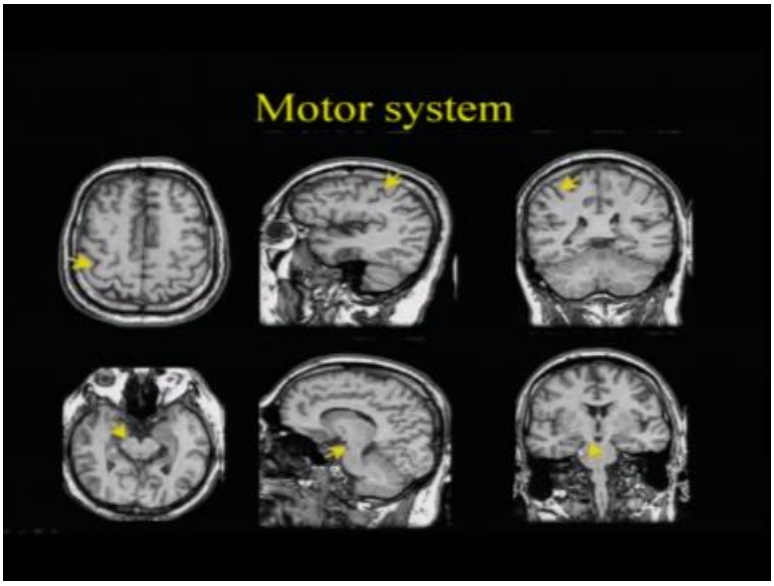
And this is the gross structure, these are cerebral peduncles, these are is the mid brain the neurons come from here and they go on to spine.

(Refer Slide Time: 23:12)



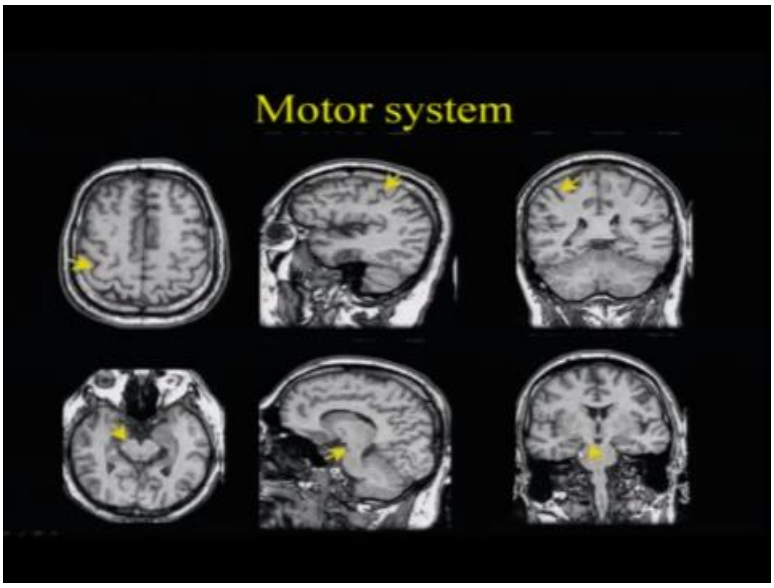
So this is a motor system again, so motor system also is included here where because there is a structure called basal ganglia here, basal ganglia and cerebellum actually fine tune the movement, initiation of movement, decision making on the movement is done in basal ganglia.

(Refer Slide Time: 23:31)



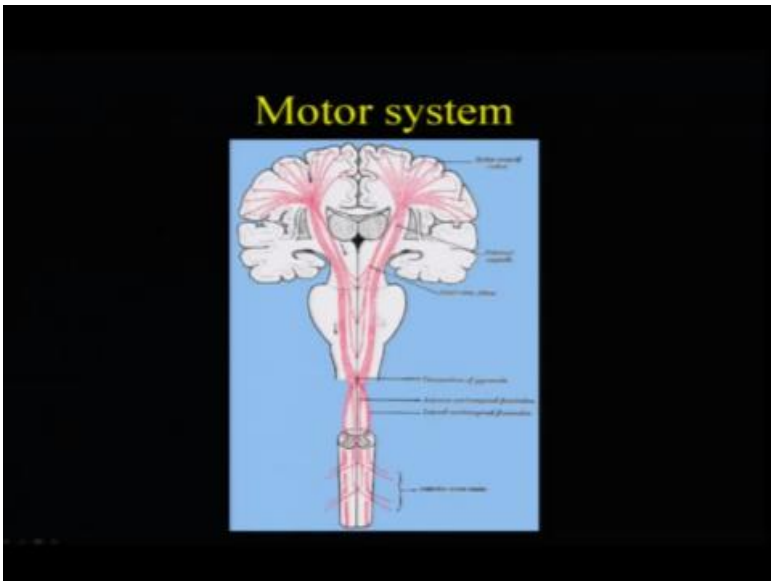
So any damage here can really lead to you would have heard of an illness called Parkinson's, it is actually a problem in.

(Refer Slide Time: 23:38)



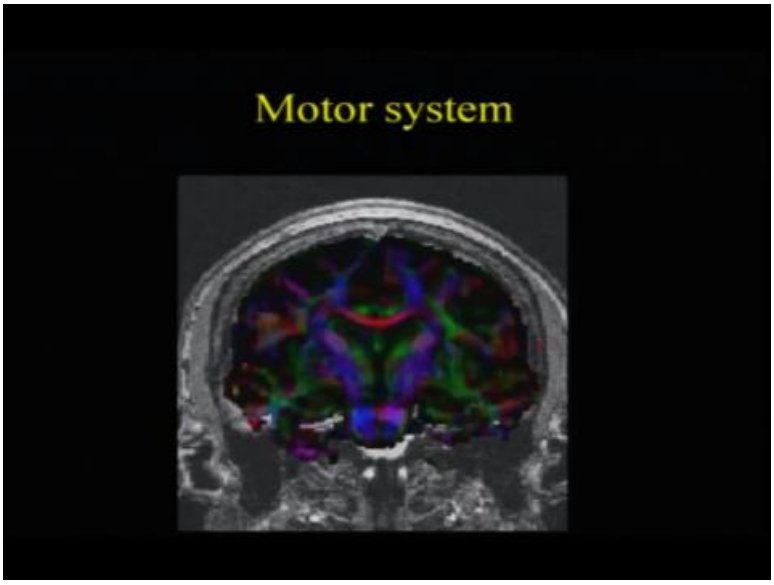
One of the areas called substantia nigra where a deficit in one of the chemicals and damage to that this substantia nigra causes difficulty in walking, slow steps and tremors. Similarly cerebellum which is tucked, here this structure is also responsible for fine tuning and whatever feedback loops come to the brain regarding your orientation in space and time, and your body, the movement of the body.

(Refer Slide Time: 23:06)

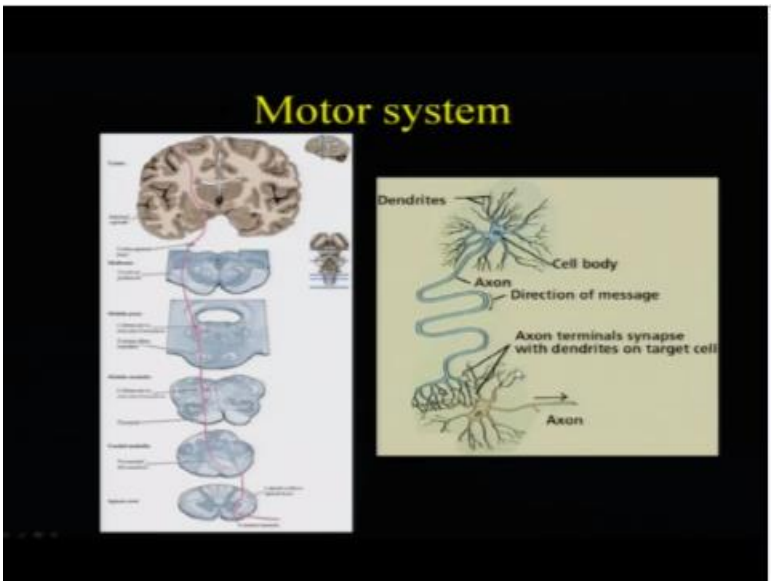


This is how again the motor system goes.

(Refer Slide Time: 23:09)



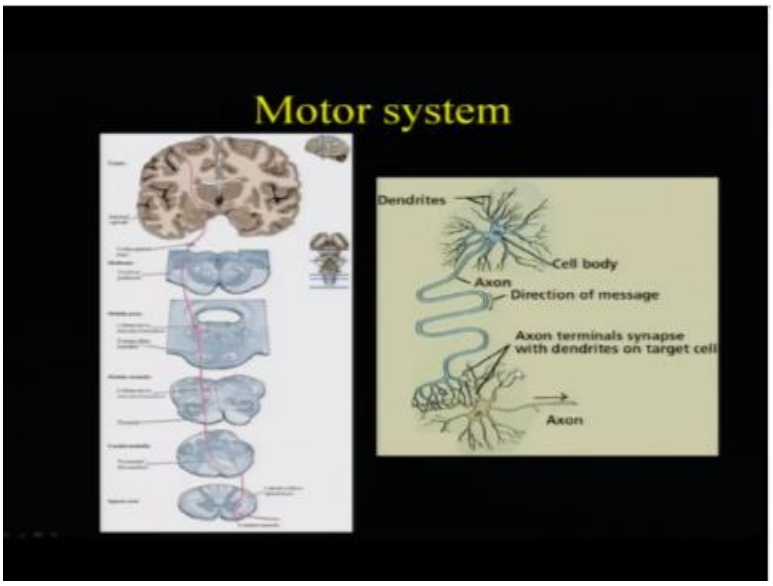
(Refer Slide Time: 23:13)



Right so this is again like the neurons start from here, go to the internal capsule of basal ganglia, go to the spine, mid brain again, and this structure in the brain, fonds, medulla, and then to the spinal cord, from spinal cord the synapse with motor neurons which goes to the muscle. This is a typical structure of what neuron is made of, there is a cell body, there are branches like this, multiple branches like this called dendrites, the cell body continuous into the axon.

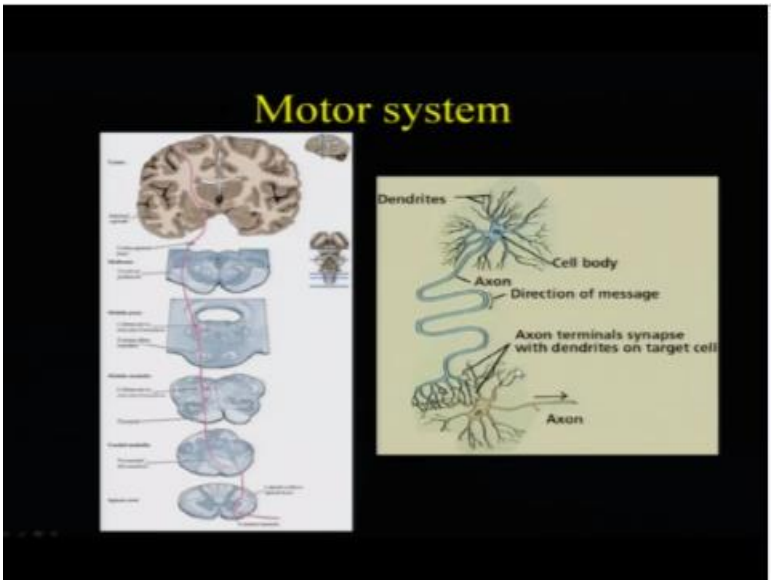
And axon and see here, but it terminates on the dendrites of the next axon and which has another axon so it will go again and turn on the dendrite of something else, so this is one structure if we look at it and this area, this area is the synapse so now you can understand almost 10^{10} neurons in various areas of the brain.

(Refer Slide Time: 25:28)



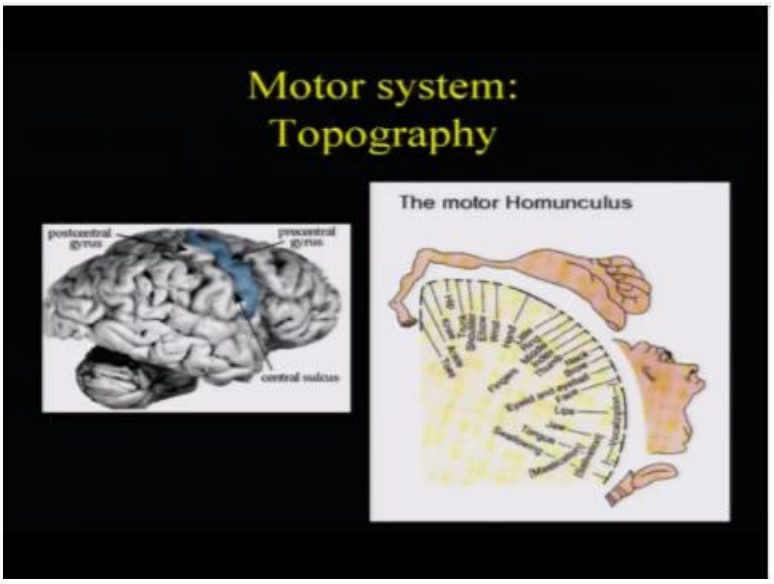
Form a huge network, each of this neuron is a body in itself which has the nucleus. Dendrites are the receiving ends, and axon is the passing end, so dendrites receive information and it is all about passing information, the brain is just receiving information from the environment, integrating it, passing it between neurons and through the network and finally taking action or a thought or emotion out of it to keep you interfaced with the world.

(Refer Slide Time: 26:09)



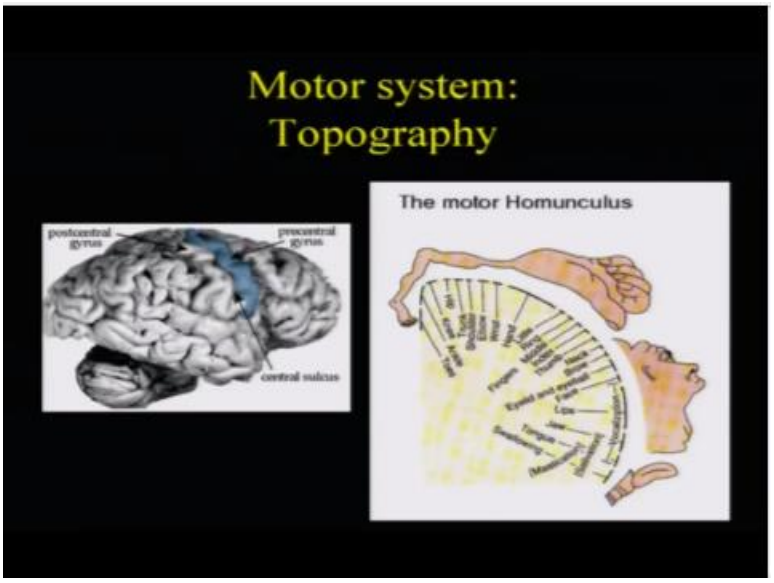
So dendrites take the information, pass on to the axon then it ends see here, that there is a gap between the dendrites and the axon, it is a space here but this space is managed through chemicals, we will talk about it when we talk about the physiology.

(Refer Slide Time: 26:28)

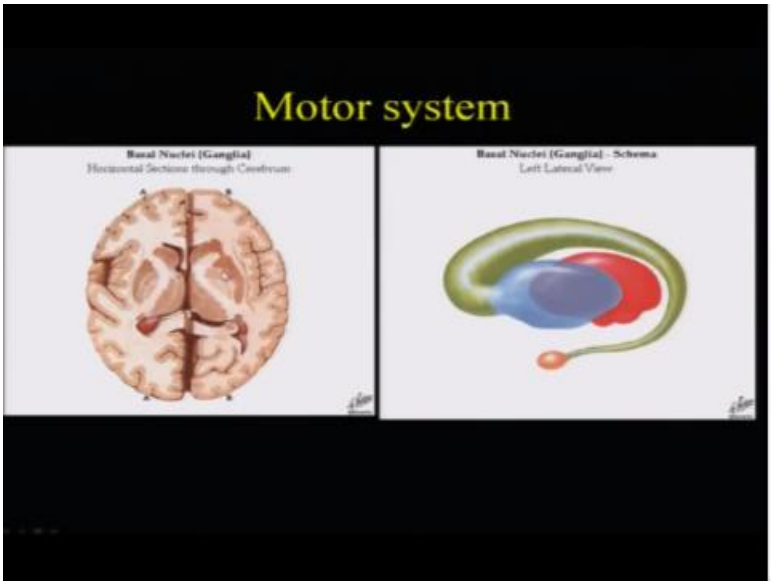


Again this is one of the, so this is what I was telling you, this is how in the parietal lobe the body is represented. On the top is foot and you can recognize your own organs, this is little ring middle index finger and has a huge representation as compared to the other thing, face has a huge representation and this is all has happened nobody has sit down and planned it, it is more a evolutionary step which brain kept learning as it interacted in it, as it turned from reptile to you and me.

(Refer Slide Time: 27:09)

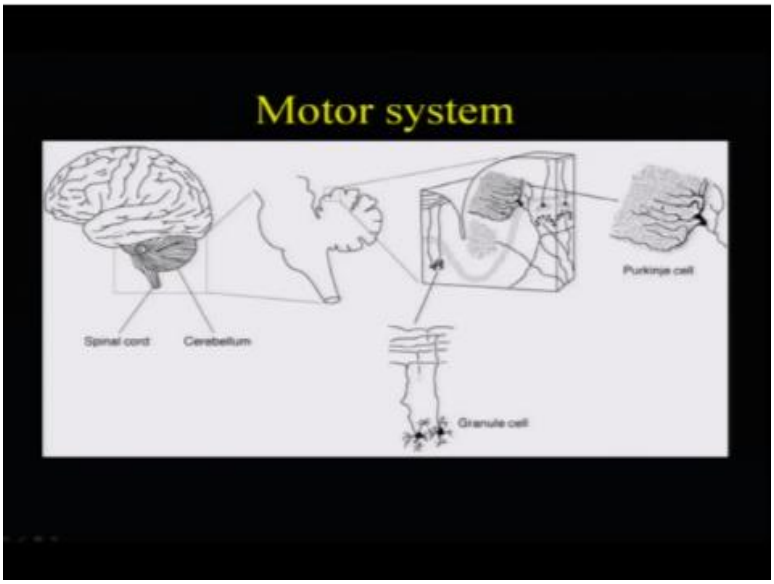


(Refer Slide Time: 27:10)



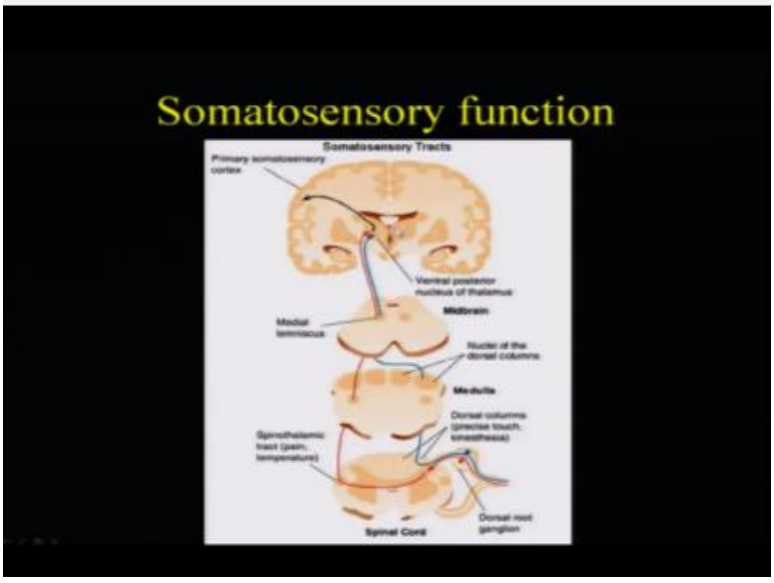
I told you about the basal ganglia which is tucked here and this is responsible for lot of fine tuning of.

(Refer Slide Time: 27:17)



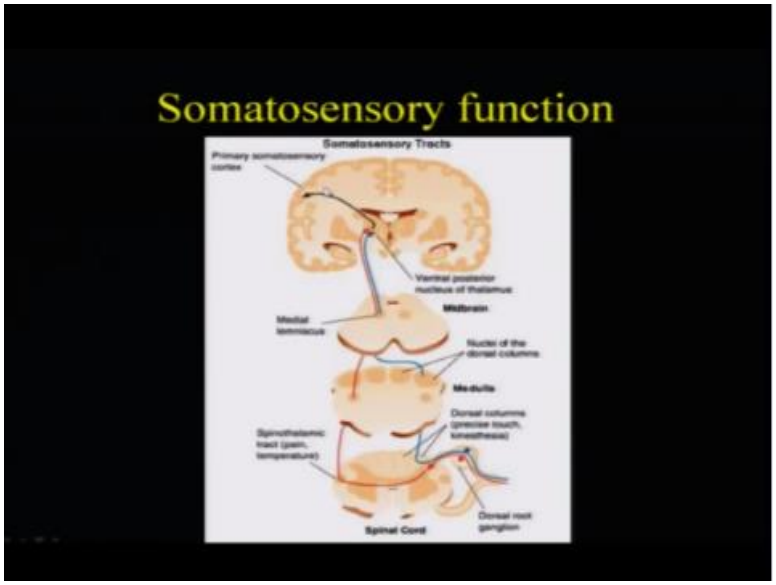
Movement and this is cerebellum if you take if just take a part of it, it appears like this, this is a different structure.

(Refer Slide Time: 27:26)



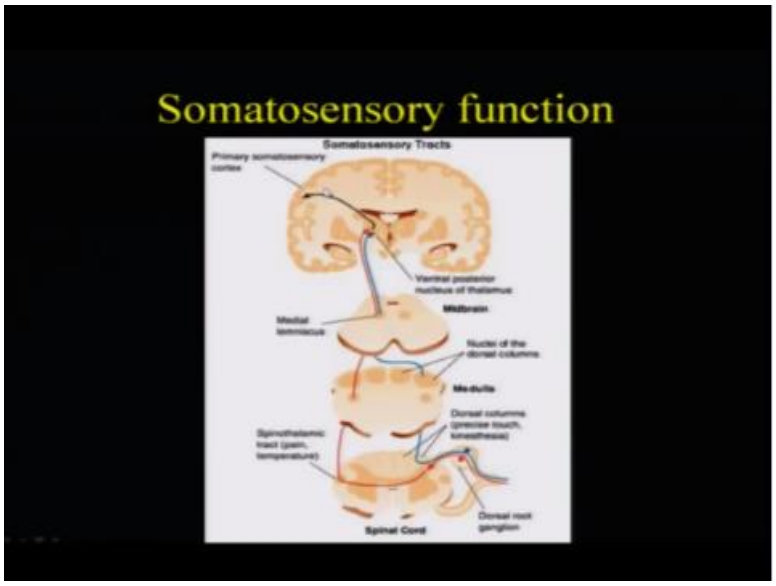
So again as you saw the motor think coming down from here to the muscle, this is how it goes up from there, if you, if somebody touches you the signal goes down, goes down to the spinal cord, goes up to the structure called thalamus, thalamus is a important structure in mid brain because thalamus is the relay centre of the brain.

(Refer Slide Time: 27:45)



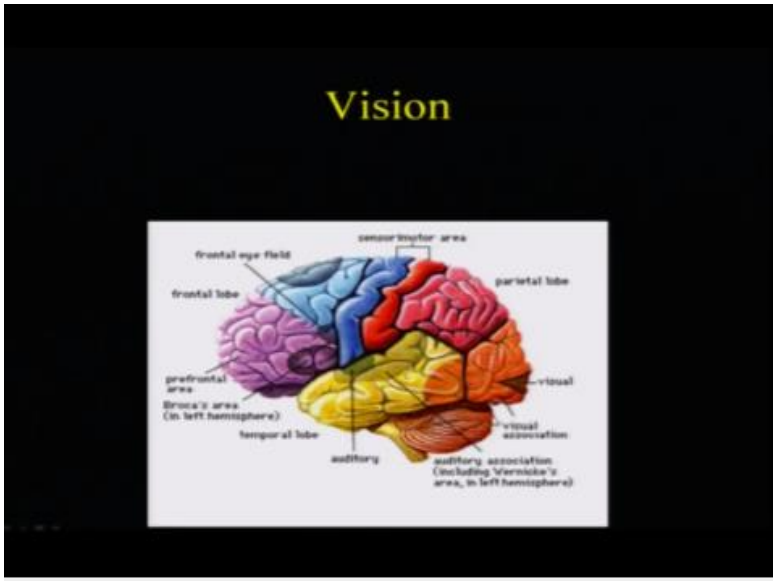
On both side in the mid brain almost intermerged with basal ganglia all sensations reach thalamus and thalamus sends it to the cortex where you feel the sensation, but all sensations have to pass through thalamus even vision and hearing and touch because this is where all sensations are integrated and given a composite view, because imagine if all other sensations are flying in five or ten directions.

(Refer Slide Time: 28:18)



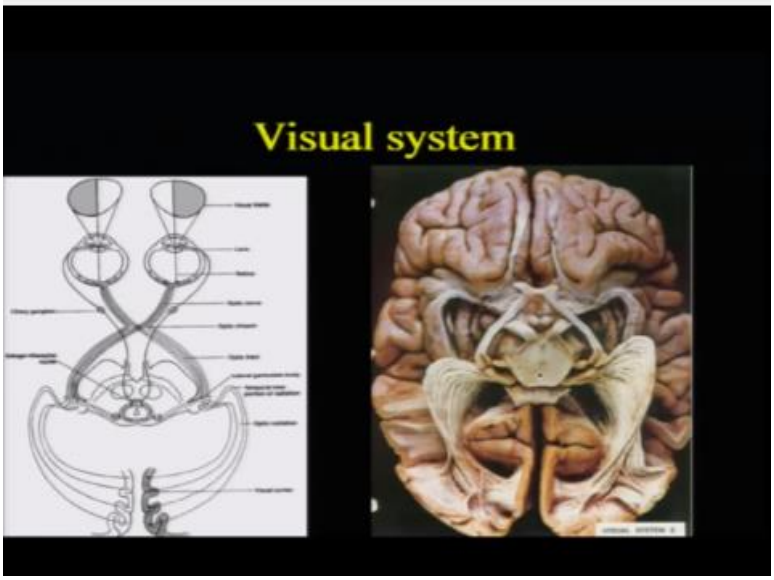
It will be very difficult for the brain or for us in that for that matter to make a sense of what is happening in the world. Even while I am talking to you there may be thousand sensations going on in your body and my body, but brain is making a composite sense of it to give me a feeling of being one and as a unity. Auditory functions we have already mentioned briefly, we will skip this, now vision.

(Refer Slide Time: 28:44)



Vision is very special thing and lot of information about brain has come from vision, this is the area of occipital lobe from where we see.

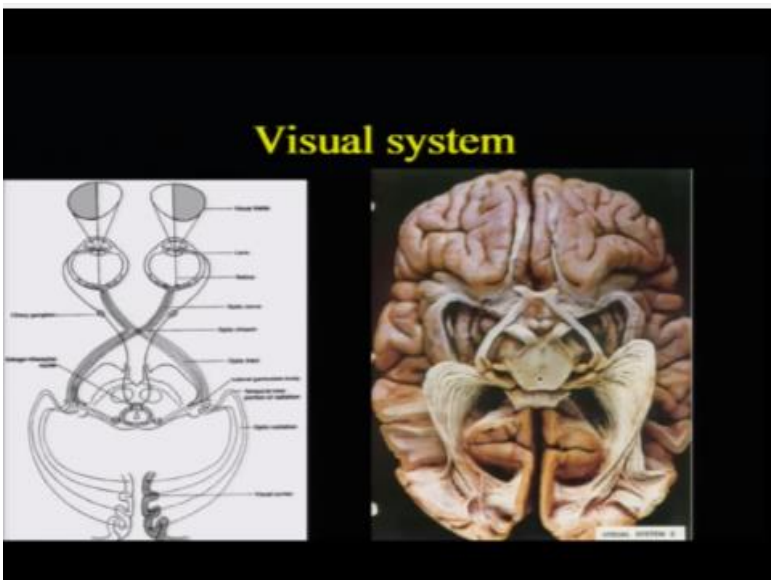
(Refer Slide Time: 28:51)



So we have 2 eyes, this you see this areas, if you divided draw imaginary line there are, these are left optical field and there is a right field, so data from this both the lefts they go round through the optic nerve go to the retina they come down it, half the fibers come like this, half the fibers cross, so eventually what is happening is if you look at it the signal from this and this will eventually come to the left side, signal from right will come to the this side so the left field goes to one side the right to the other side.

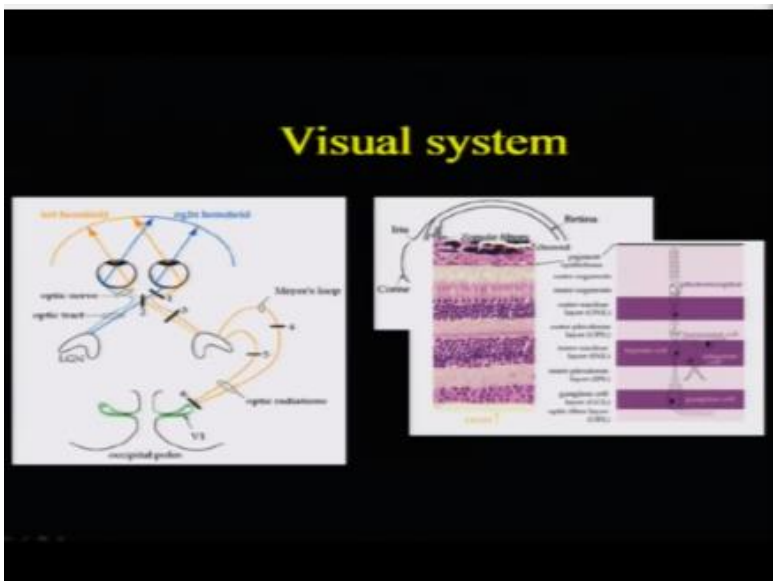
This is for the binocular vision, otherwise we would not able to see the, it is like you are taking signal from 2D and you are seeing in 3D. Although it is a 2D vision so but and that is why you feel differently when you are seeing a, it in 3D but brain has to create the image.

(Refer Slide Time: 30:00)



Of the objects, it is like creating 2 copies for us to better comprehended it in a.

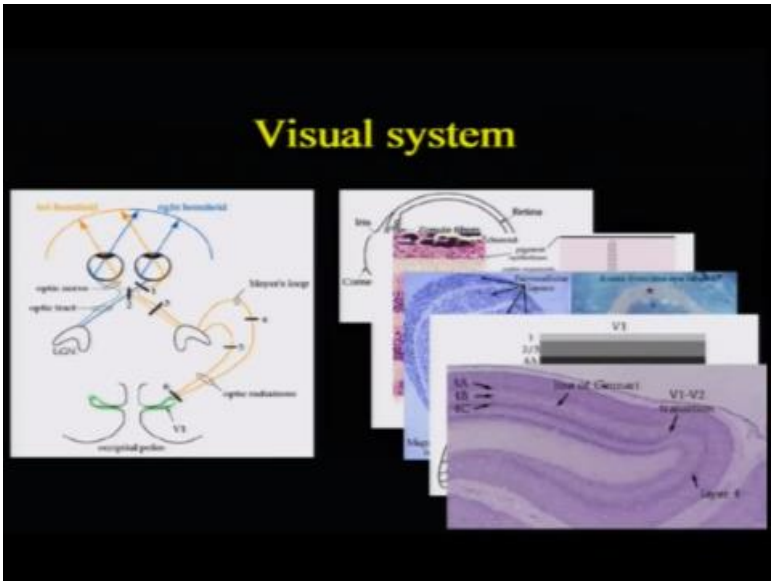
(Refer Slide Time: 30:06)



3 dimension, you can see this further, so right hemi field is going here and the left is going through crossing, you can just drag, drag the fibers and finally it go to, goes to both the sides to create a, so light goes in here this is like photons go here, go to retina, bind with some certain pigments there, change the, the shape of this which sets in an electrical current which goes to the optic nerve, optic nerve goes here, half of them cross, half of them cross here, before that they go to what you call a lateral geniculate nucleus which is a part of thalamus as I said, so from here it goes to occipital lobe.

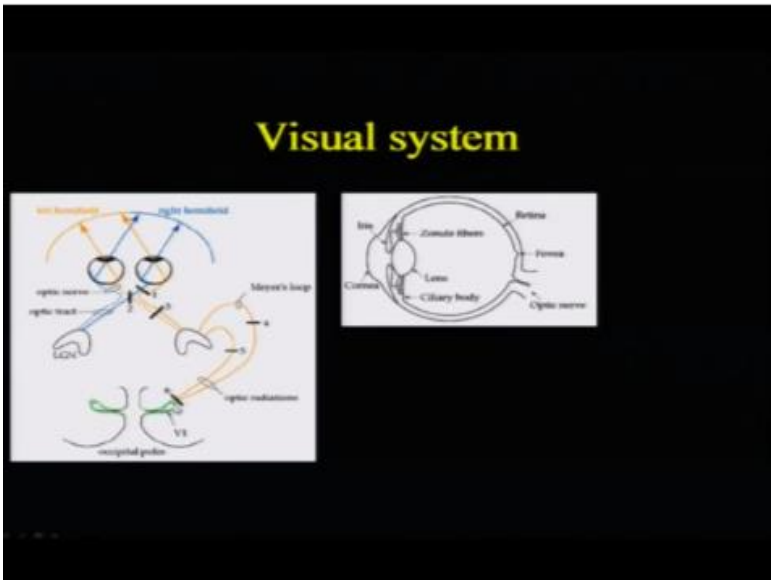
An occipital lobe has these layers of cells, now these layer from 1 to 4 are specialized to capture movement, to capture shape, to capture the contrast, so if you just for a second.

(Refer Slide Time: 31:22)



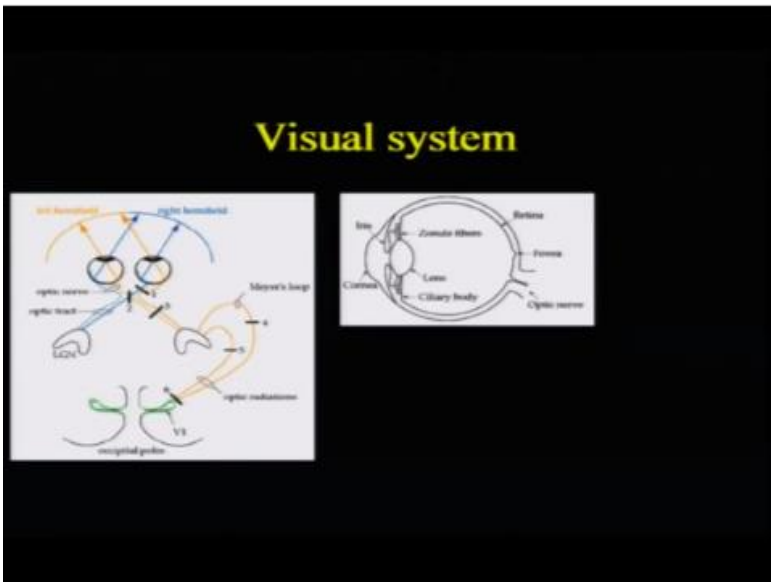
Look at the whole thing and see how wonderfully nature has really made it let me go back to.

(Refer Slide Time: 31:30)



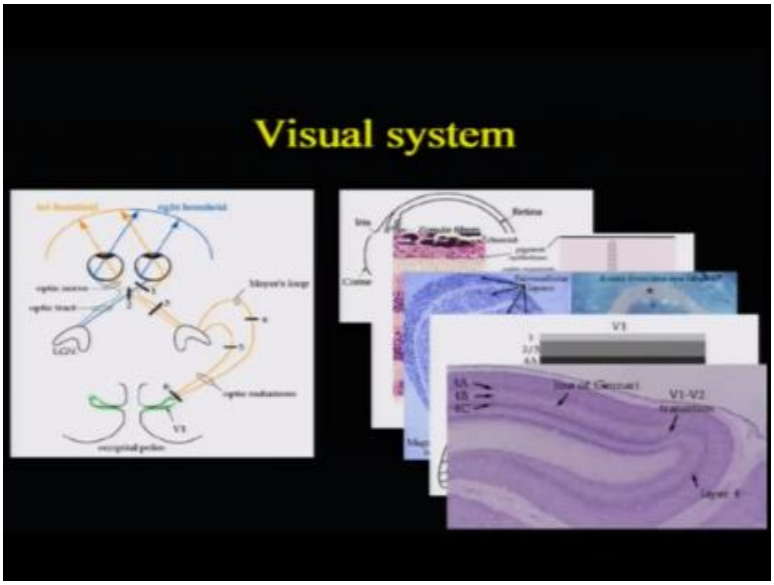
Some signal goes in from here in the form of photons which is electromagnetic radiation, goes to retina photons bind, send in an electrical current and this electrical, so there are, there are multiple of them, so all the photons are going and this electrical current divides into this neurons goes to the mid brain where the integration of signal happens and then it goes to the occipital lobe from layer 1 to 6, the various feature extraction is done just by interpreting the electrical current.

(Refer Slide Time: 32:09)



And the images form, this image again is transmitted to the frontal lobe, in the process it is compared with the existing memory or map of the image in the brain which this area does, and then a composite image comes to your brain on which the bases of which the brain decides whether it wants to act on it, it wants to ignore it and this is, this is how the brain keeps you in touch with reality.

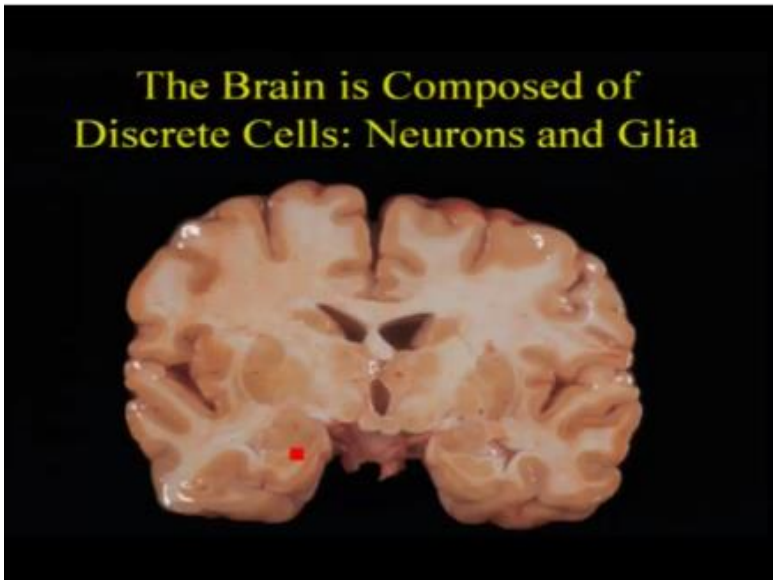
(Refer Slide Time: 32:43)



So these amount of specialization of cells has evolved over millions of years, not each layer does the same thing, not the same set of cells sees the whole thing, some part of this layer is seeing the movement, some part is seeing the color, some part is seeing the contrast, and that whole information is put together to form a composite image of what you are seeing, which again is compared with the existing, if there is a existing memory or map of that object and both of them are compared to give another composite image to the frontal lobe where the pre – frontal cortex decides, and the other networks which I will talk about decide on what to do with it and this is how the mind or the brain keeps you safe, imagine, imagine a lion attacking you.

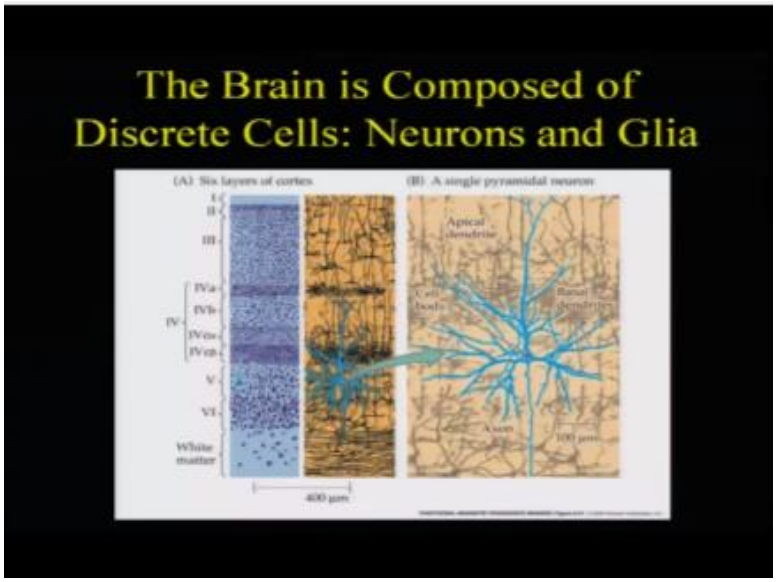
Now whatever light is reflected from lion will go into your eyes, a image of lion will be formed, this image of lion will be sent to your mid brain where your mid brain will look into the memory of lion and decide that this animal is dangerous, and then it will send to pre – frontal cortex where it will decide to make you run because if it fails you are dead you are, you will not be there to look at another lion and all this happens in say a period of say 10 milliseconds to say 500 milliseconds, okay.

(Refer Slide Time: 34:15)



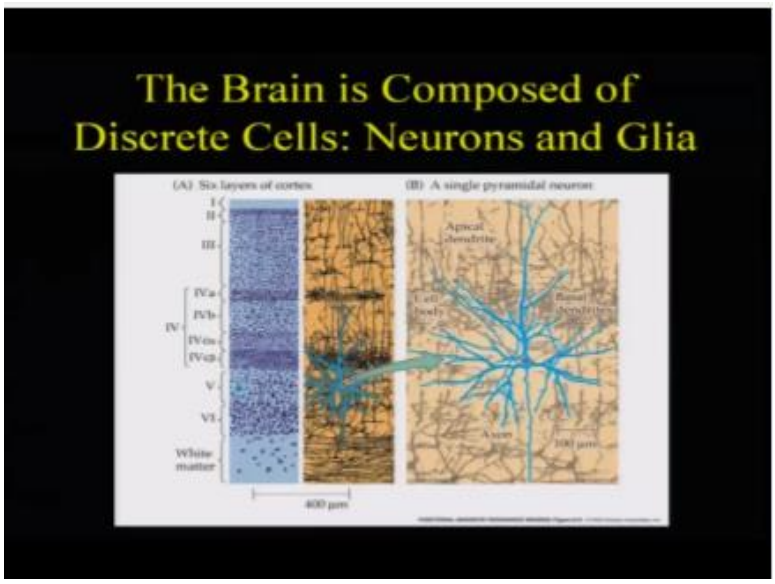
So now we know the brain is composed of discreet cells, neurons as I told you.

(Refer Slide Time: 34:22)



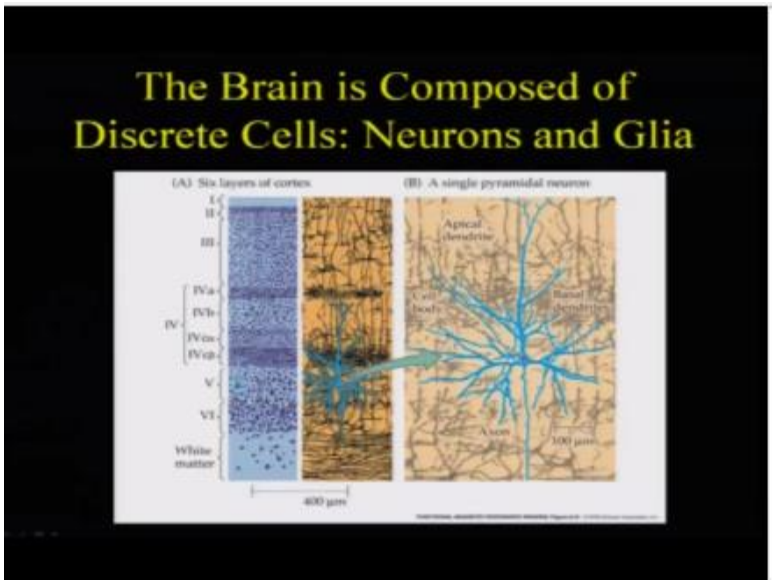
And there are set things called Glia cells which are much more than neurons and they are wide spread in the brain between neurons and they have different functions like packing, being used as a packing material like being used as a scavengers in case of infection, one of them actually also buffers the sodium potassium electrolyte level. So the brain is composed of this six layers which vary from area to area.

(Refer Slide Time: 34:47)



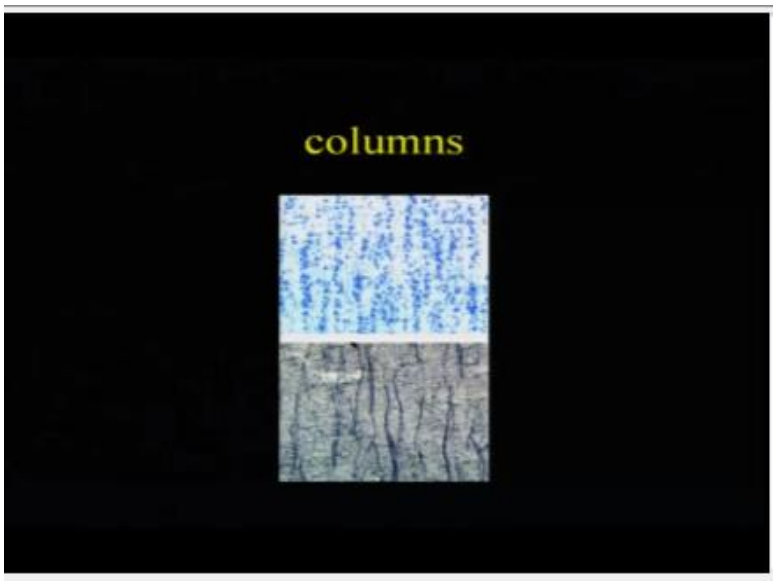
This the first one or two layers are mostly composed of cell bodies and dendrite as you, you can see in this image, dendrites, cell body, axon, this is taken from here but the layer fifth and sixth are the most important because these are called pyramidal cells, now pyramidal cells are obviously the word is self explanatory and the layer six, so in the layer four all the inputs from thalamus come, this is the fifth, layer fifth is from where all the commands go, the motor command and connections to the other areas of the brain to the spinal cord.

(Refer Slide Time: 35:26)



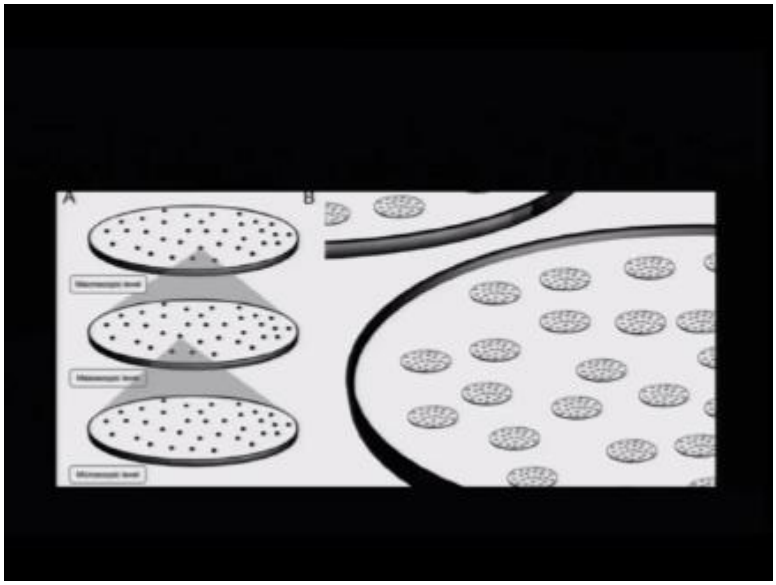
And layer six is the feedback from the cortex to the thalamus again, now these layers may vary in different areas depending on the function of the area, like in some areas there are only three layers which are more developed, in some area there may four depending on what function that area is.

(Refer Slide Time: 35:53)



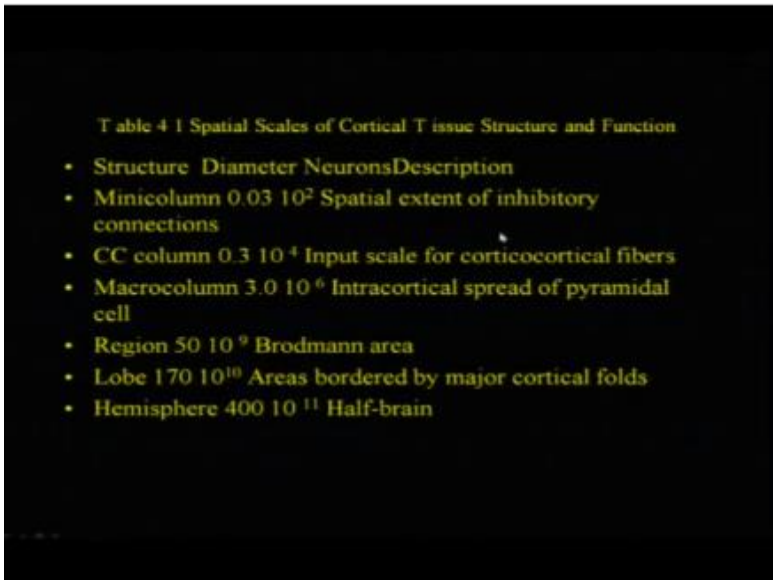
But all this neurons if are, if you look at this, this histochemistry they are arranged in the form of columns, so there are micro columns and there are macro column, there are no clear division this not as if it has been put it in a envelope or a cylinder, but they are arranged in a form of a column when you look at it, functionally it may not be necessary that all columns should fire together on a, on a certain action. The neurons which fire together can be separated faraway with from each other, how the function will; we will just come to it.

(Refer Slide Time: 36:32)



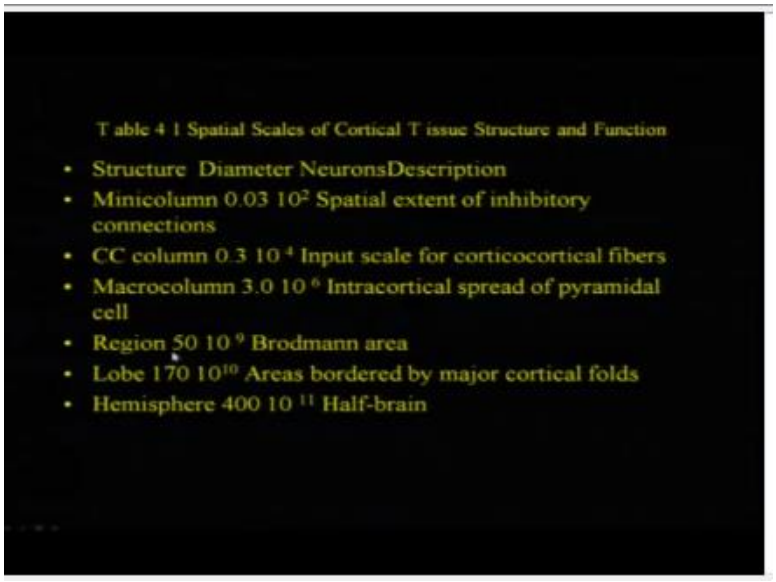
Now this is how it looks at a microscopic level these are the columns, increase the scale it is like this and each, so there are multiple, each of this micro column are fitting into these macro columns.

(Refer Slide Time: 36:47)



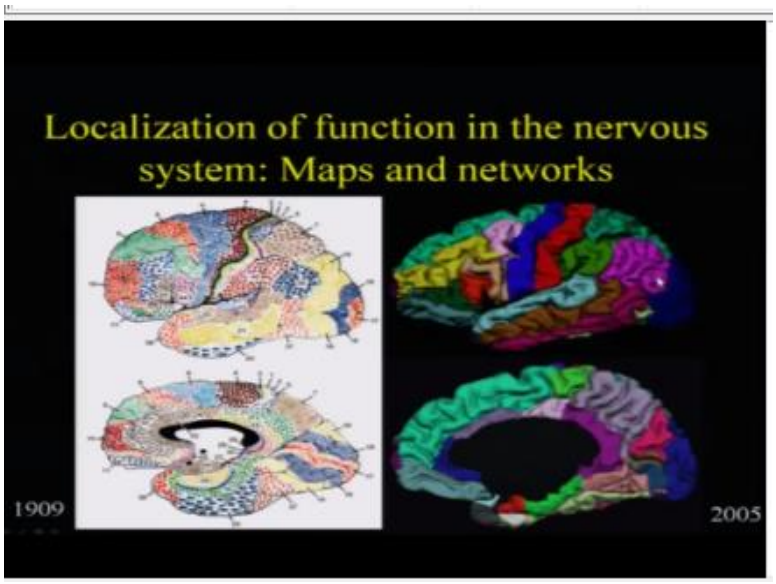
If you want to look at this scale it is like this, mini column is 0.03 and the scale of 10^2 these are mostly innovatory connections, cortico, cortico within the cortex if the connections go like 0.3 x 10^4, macro column is almost three, this is millimeters and 10^6 so see the increase, see the increase, so number of mini columns which can go into this and as you go into the region which are largely called Brodmann areas, functional Brodmann areas as I showed you the that okay this is the area for hearing, this is the area they are called Brodmann areas.

(Refer Slide Time: 37:28)



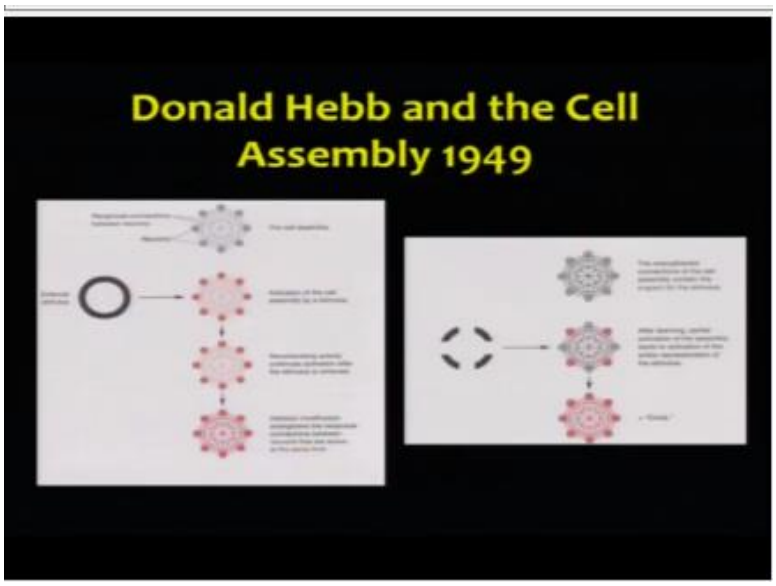
Each lobe has, this is the scale and 10^{10} and each hemisphere has 10^{11} that is half the brain, each lobe means frontal lobe and parietal lobe hemisphere, so see the increase in the scale in millimeters and the increase in number of the neurons and as it is seen grossly.

(Refer Slide Time: 37:50)

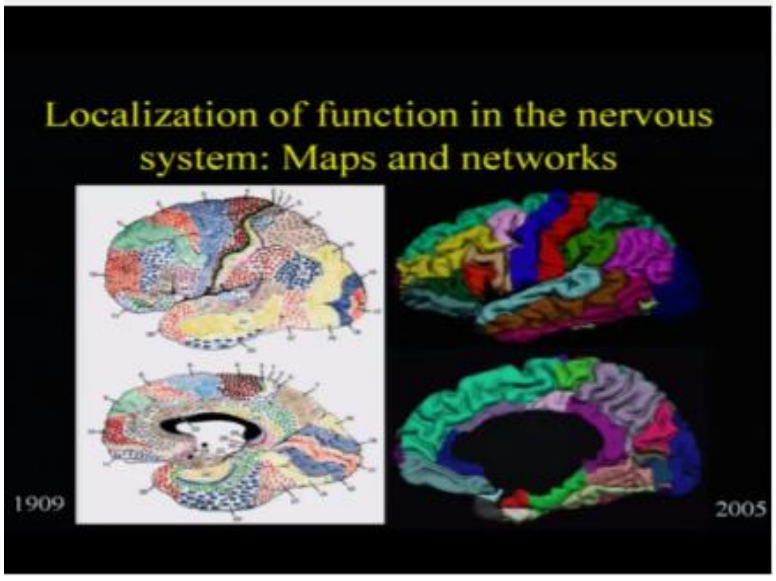


So these are the Brodmann areas which have been numbered like 21, 42, 44, 44, in Broca's areas so on so forth, so these are broadly divided according to the function.

(Refer Slide Time: 38:03)

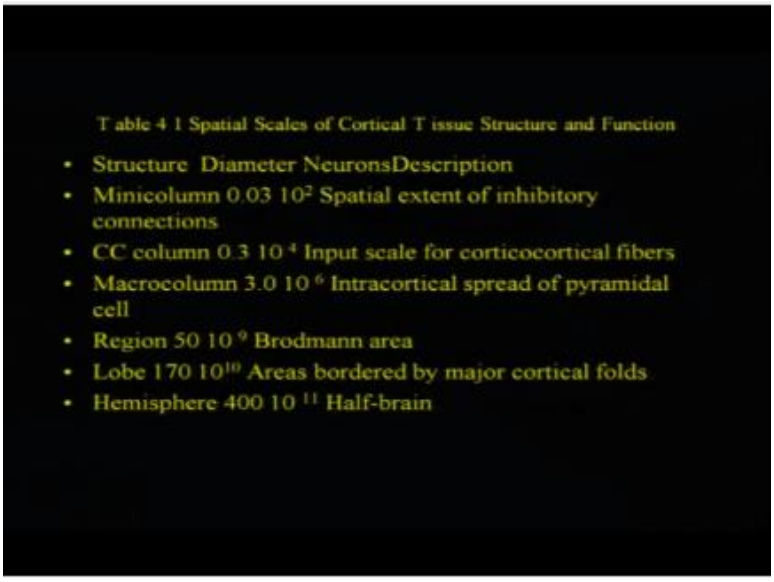


(Refer Slide Time: 38:05)

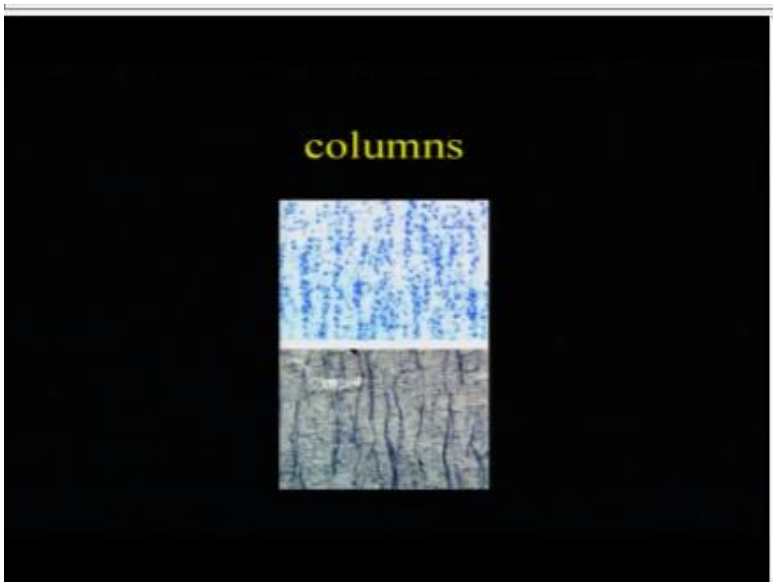


But does it mean that all the columns, all the cells in one column like this all have to fire together?

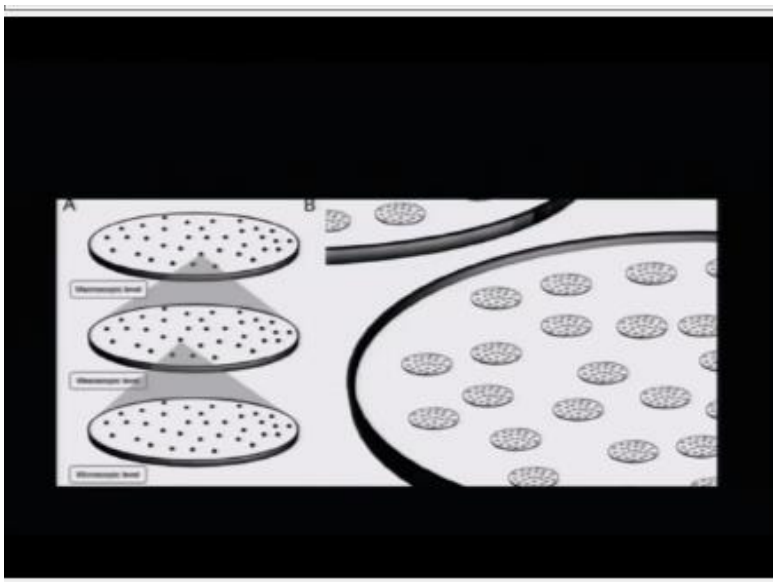
(Refer Slide Time: 38:07)



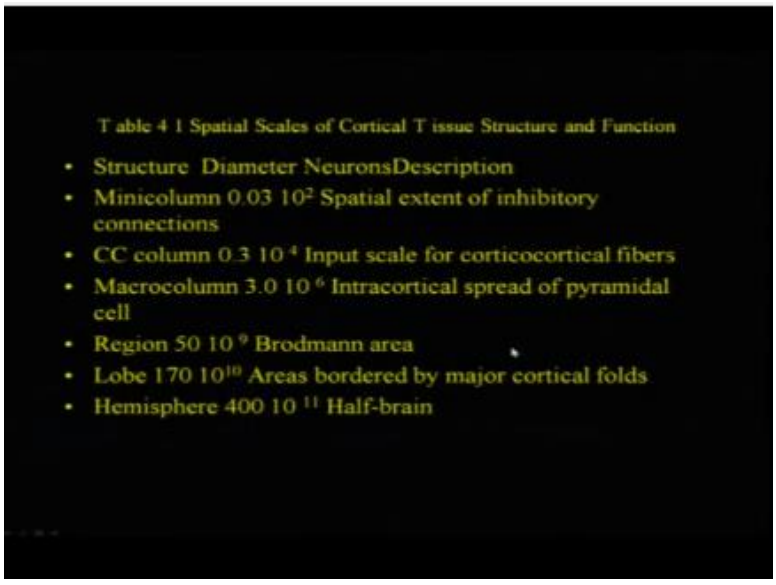
(Refer Slide Time: 38:09)



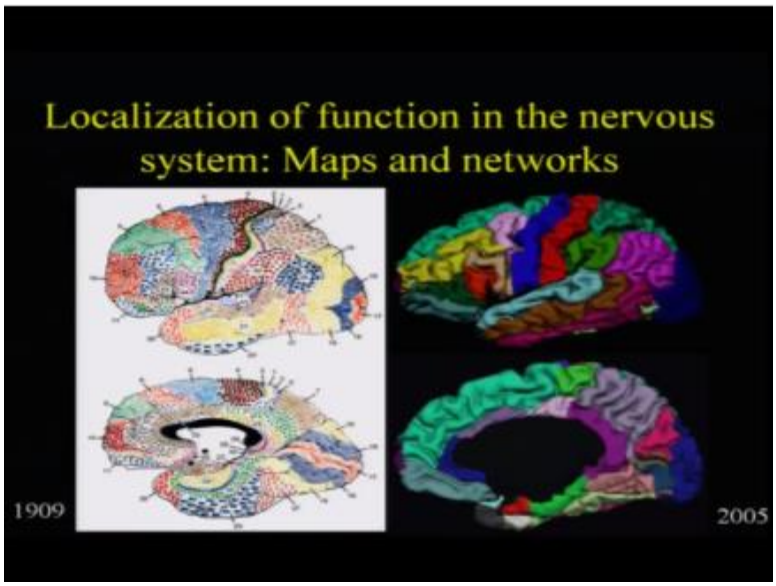
(Refer Slide Time: 38:10)



(Refer Slide Time: 38:12)

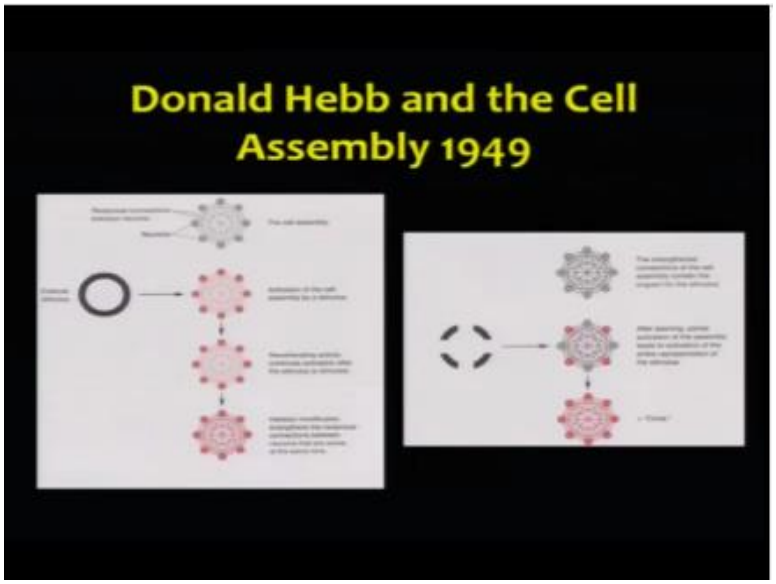


(Refer Slide Time: 38:14)



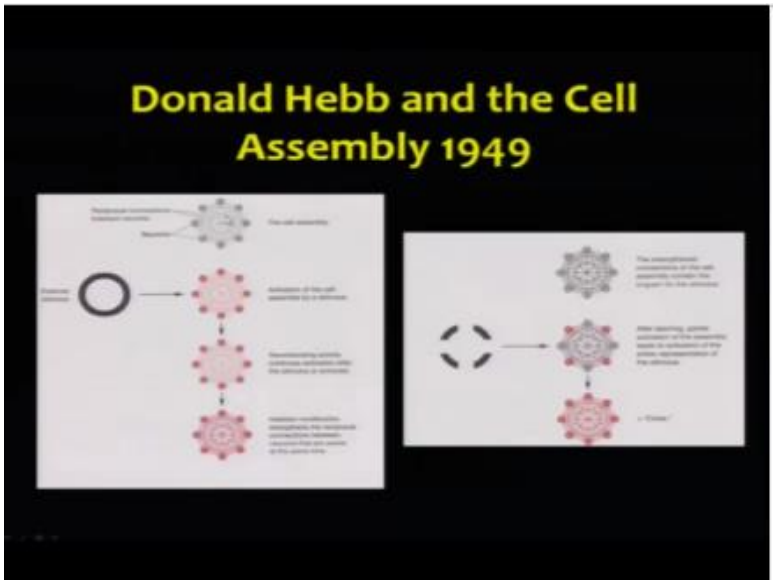
Or all the areas which are specialized will fire together, as in when the action arises?

(Refer Slide Time: 38:23)



It has been found that is it not so, it is in fact the neurons may be sitting somewhere else but they may be firing in coordination or in conjunction with neurons sitting somewhere else, it was almost like neurons which fired together they wire together, so wiring together does not mean that they have to be in the same geographical location in the brain, they can be sitting but their action may be determined by the firing of some other neuron sitting somewhere else.

(Refer Slide Time: 38:56)

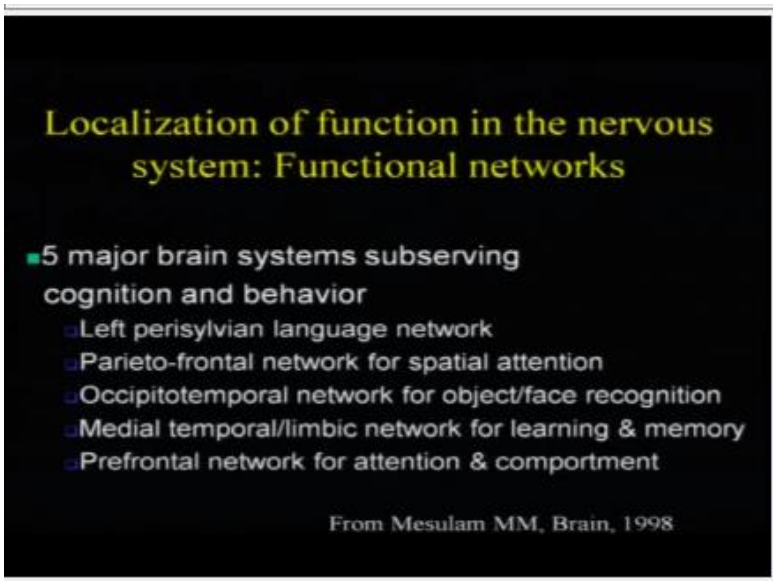


Now this is like a from the graph theory, if you make a graph of how the neurons can act, so they are called Hebbian Assembly, they are modify they are strengthening of the connection between the neurons is when they become active together, like for example in say let me give an example if the in the case of memory if certain memory has to be activated all those neurons which were involved in forming that memory will fire together.

So they may not be necessarily in the same place, they may be scattered in different areas like for example if you say a word rose, some of you may smell rose, some of you may see the color, some of you may see the petal, thorn, touch anything can come, so it is very unlikely that there will be a block sitting in the brain where it will be all about rose, no, no, then the whole memory will be scattered.

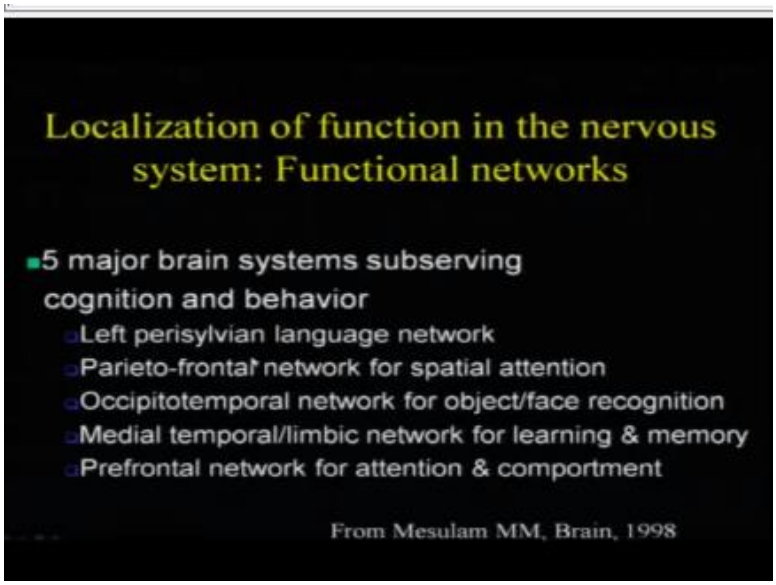
But one point as it triggers all this will get activated, they are Hebbian Assemblies, Hippocampus is a area in the brain deeply tucked in temporal lobe which is responsible for memory mostly, informing memories because the weight fires increases the synaptic strength which is called potentiation in the case of memory. And the other areas which have motor memory the other area which have all fictive memories so there five largely, five big networks.

(Refer Slide Time: 40:32)



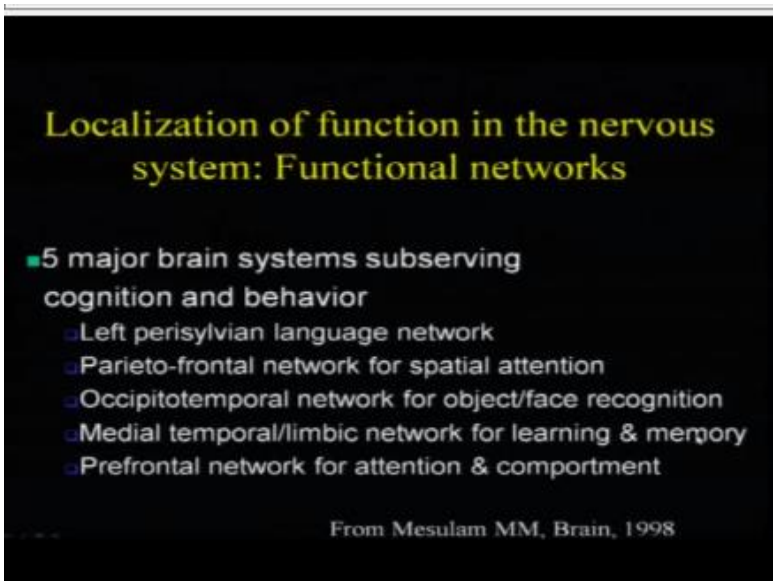
Which function as forming and connecting all this, one if you can just remember the names but look at it Parieto – frontal networks for spatial attention so it is all about orienting in time and space, so parietal lobe where you get feedback from the body all the sensation from the touch on the heart, your orientation you are standing and which passes the message and integrates with the frontal lobe.

(Refer Slide Time: 40:58)



Which controls your body tone, body movement and keeps you oriented in the space, occipito temporal from the back end temporal for face recognition, temporal lobe and limbic system, limbic system is the emotional network which is tucked within the brain, within the cortex for learning and memory.

(Refer Slide Time: 41:22)



Pre – frontal network for attention and compartment, so largely if you, broadly if you look at them you can call them three networks, one is called a default mode network which is the neurons which are active at rest, there is a central executive network the prime area of which is sent it also let a pre – frontal cortex and simulate gyres, and these are salience network, the salience network also looks at the features extraction, looks at the important thing on what you are seeing.

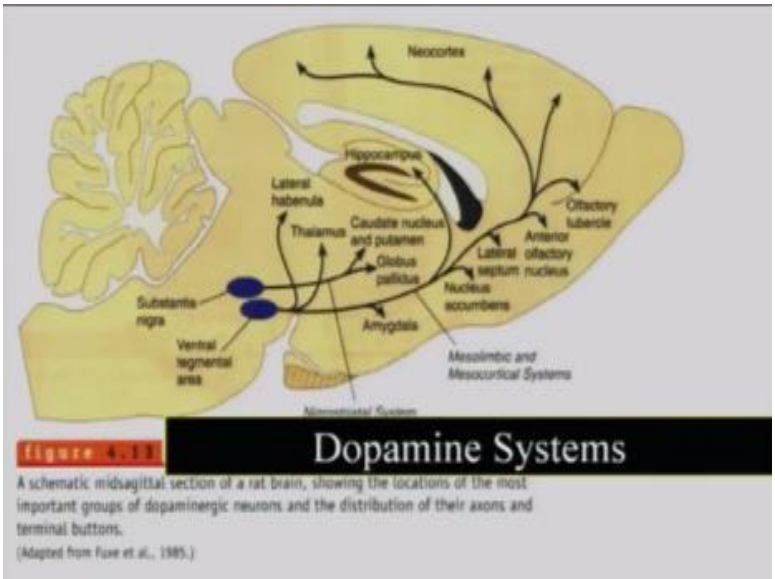
And what you are reacting to, so all these three, four networks actually keep you what you are, they are the mind through this networks always tries to keep you in touch with reality and at the same time managing the deeper emotions and your thought and whatever is being internally generated at the same time, but the larger purpose of this one is survival because if you are not in touch with reality survival may become difficult.

So first and foremost is survival, I am taking actions and doing motor movements and feeling sensations and feeling emotions and thought which will keep you in the best fit in your environment. That is one concept of normalcy also that you are best fit in your environment. So all that normalcy comes from this firing of networks and then when I stimulus is presented to take that stimulus in, to analyze it, to create a image of it, to integrate in whatever existing memory and maps you have.

And then presenting it to the brain to take action on it, which maybe most apt. Memory which is formed through whatever stimulus is presented, if your brain keeps firing on that for some time it will become a memory.

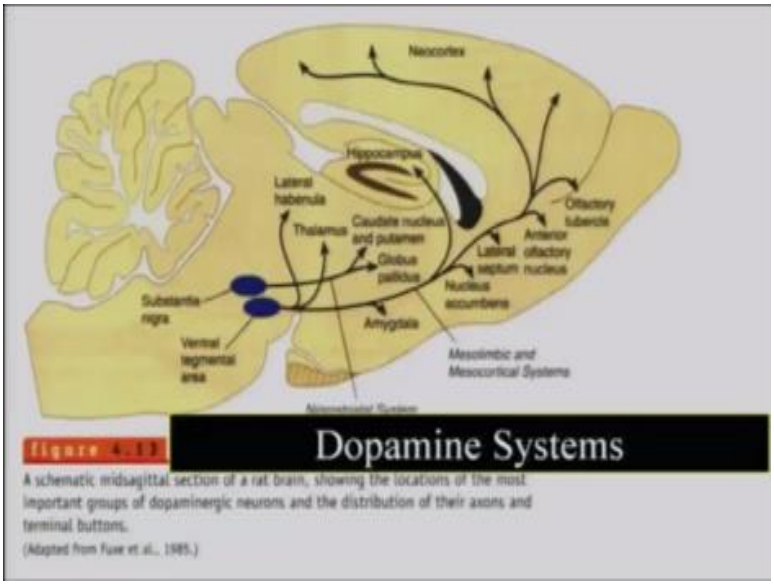
Sometimes the sudden memory, the sudden impulse which maybe very, very intense can alter this, so these are like synapses which are made between neuron and as I said if they fire together they wire together. So broadly I have not tried to get into deeper things of anatomy, but this is what how the largely the brain function, it takes in, creates a image, compares it with the existing memory presented to the higher centers which take a decision on whether to act on it or save it or emote on it. So as I said the glia's are the supportive cells which are.

(Refer Slide Time: 44:00)



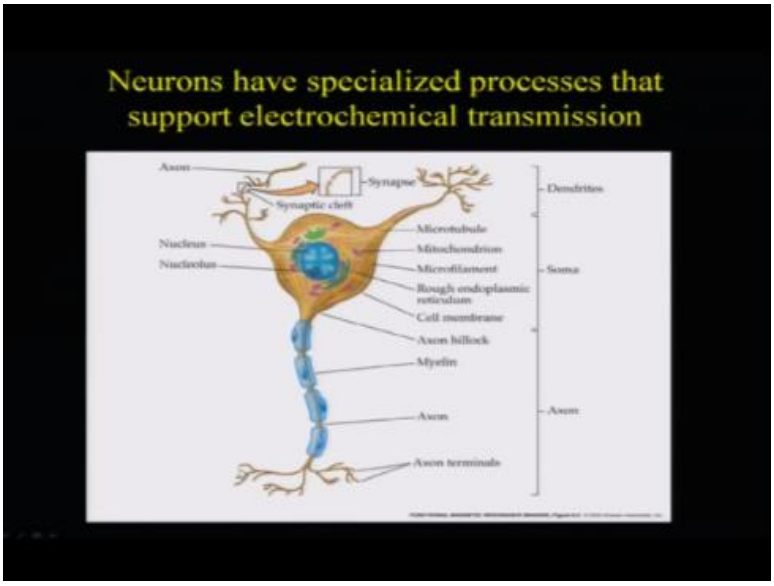
How does it happen? It happens through all this, once the brain gets active and its electrical activity is on it never stops till somebody really falls ill or dies and brain death.

(Refer Slide Time: 44:15)



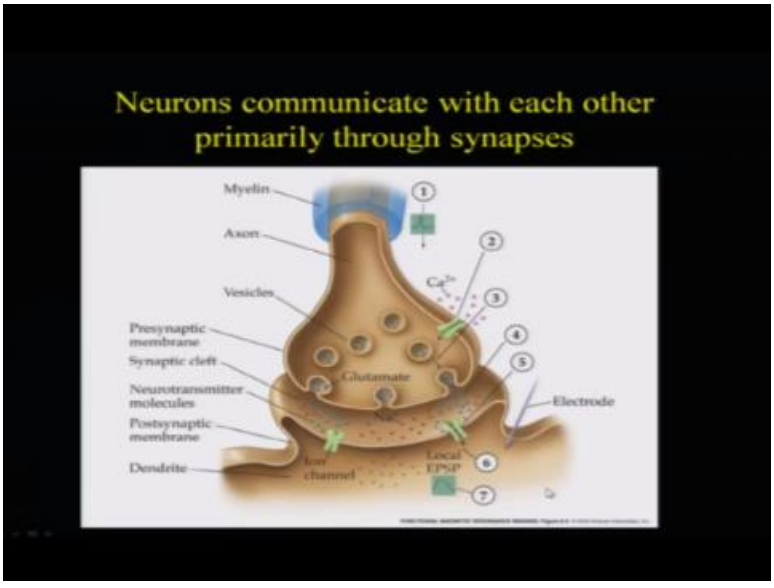
Is the death actually, so it keeps firing and as, as you had seen in earlier slides each neuron connects to the other neuron through, through dendrites and the end of the axon. There is a gap as I said, synapse what happens between the synapse. So it is a electrical activity which is going on in the brain between this 10^{11} neurons. And each neuron is connected to the other or many like on a dendrite many axons may descend. But how to they cover that small gap which is a non-contact area which is called a synapse, the electrical signal changes to chemical signal there. So ultimately brain functions through electrochemical signal. Now what axon.

(Refer Slide Time: 45:10)



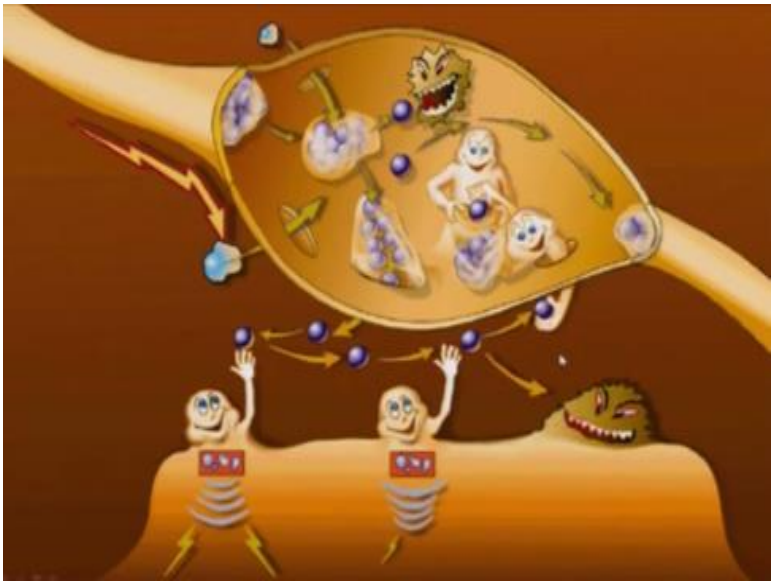
So if you see it here, this is a synaptic cleft. This is a gap, this is a gap, so each dendrite here would be receiving each dendrite here, this is a dendrite each dendrite here has the axon coming from another neuron and this is the synaptic cleft, you see it. Now this synaptic cleft how does it bridge, this is the electrical activity flowing on air and these are myelin sheath with glia's at the mid. This myelin sheath actually makes the speed faster, current action potential we will talk about it in just a while. It goes on like this it comes here but how does this axon transfer this, this is through the chemical which is called a neurotransmitter.

(Refer Slide Time: 46:12)



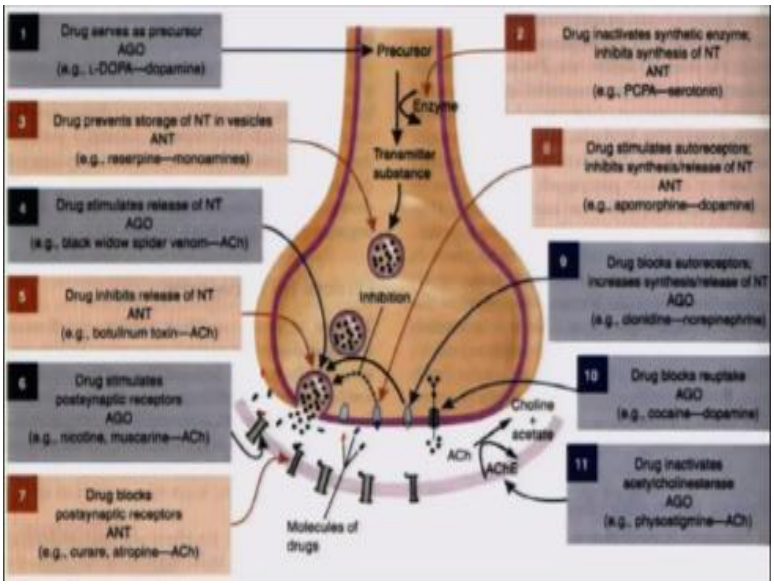
If you look at this here, this is the myelin sheath, this is the axon, the current is coming here and it is secreted into this space, the dendrite the other neuron takes this chemicals and another set of electrical activity goes into it.

(Refer Slide Time: 46:38)



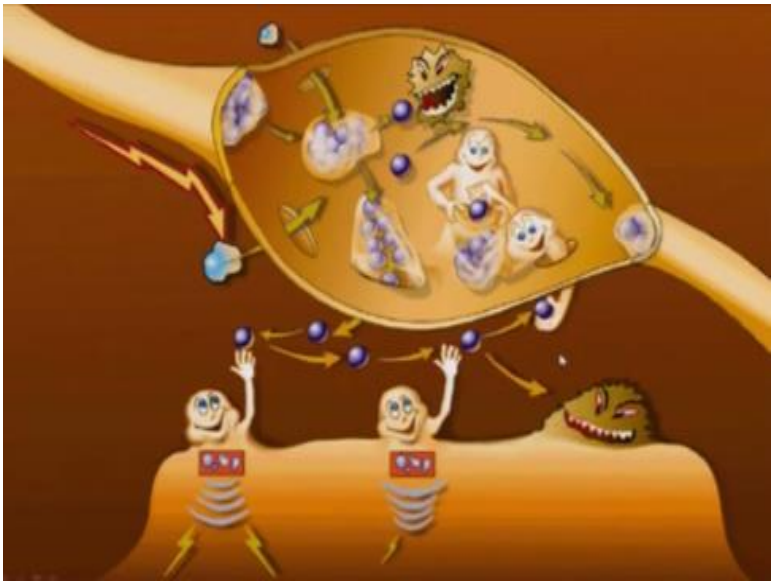
Look at it, comes on air and these are receptors, these are neurotransmitters secreted from air, it is just a cartoons.

(Refer Slide Time: 46:51)

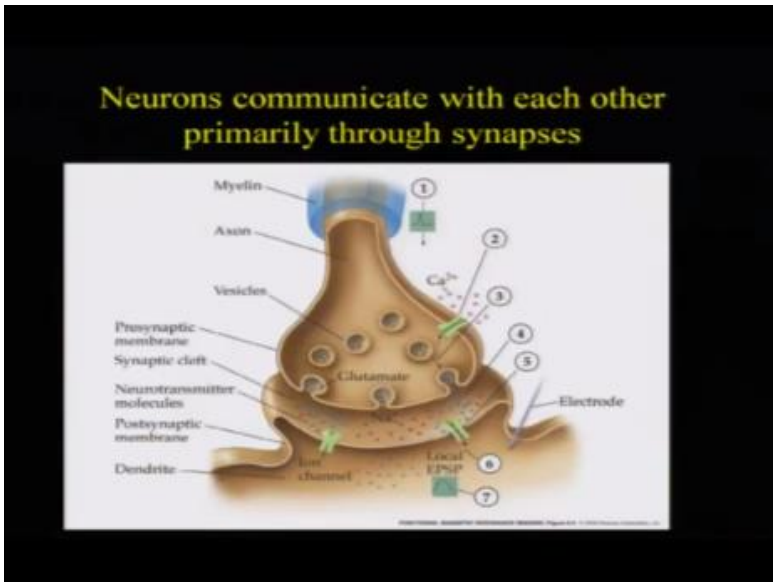


It comes here, this is the whole bases of.

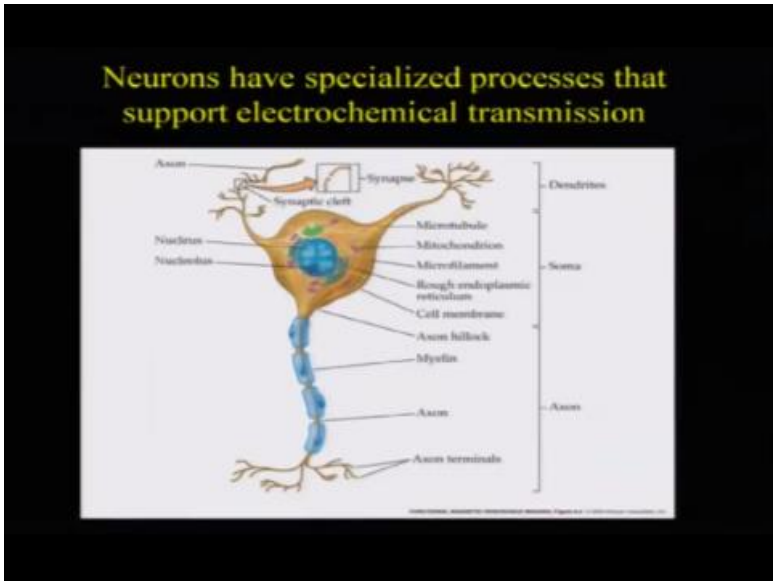
(Refer Slide Time: 46:59)



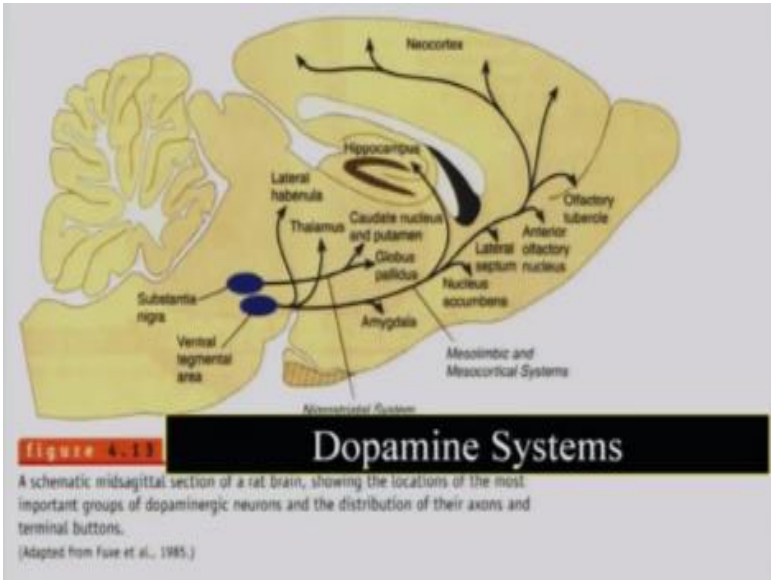
(Refer Slide Time: 47:00)



(Refer Slide Time: 47:01)

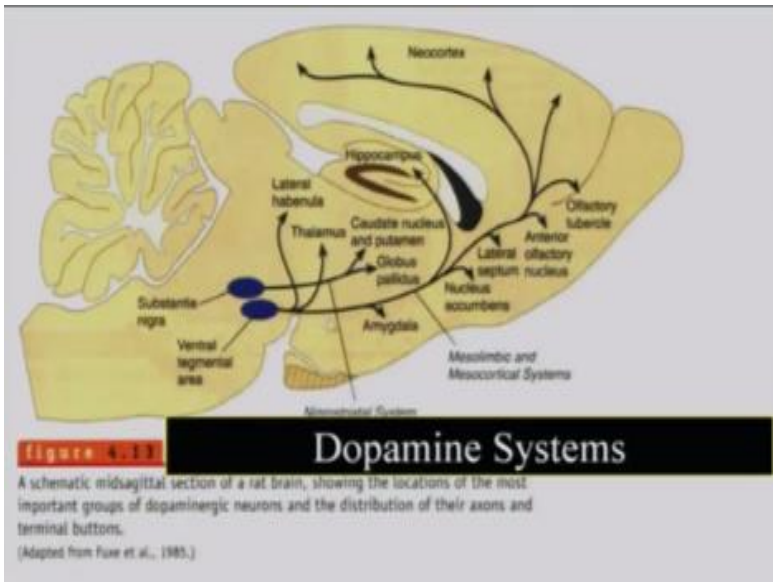


(Refer Slide Time: 47:01)



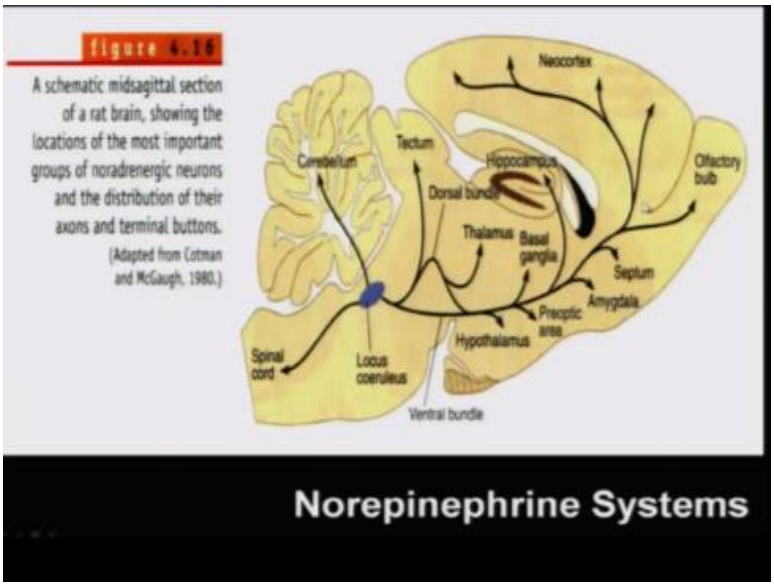
Functioning of brain. Now there are many neurotransmitter, each set of neuron specializes in secreting one type neurotransmitter and they have a concentration in certain areas of brain. But the receptors are there for lot of them, the dendrites have receptors for lot of them.

(Refer Slide Time: 47:24)



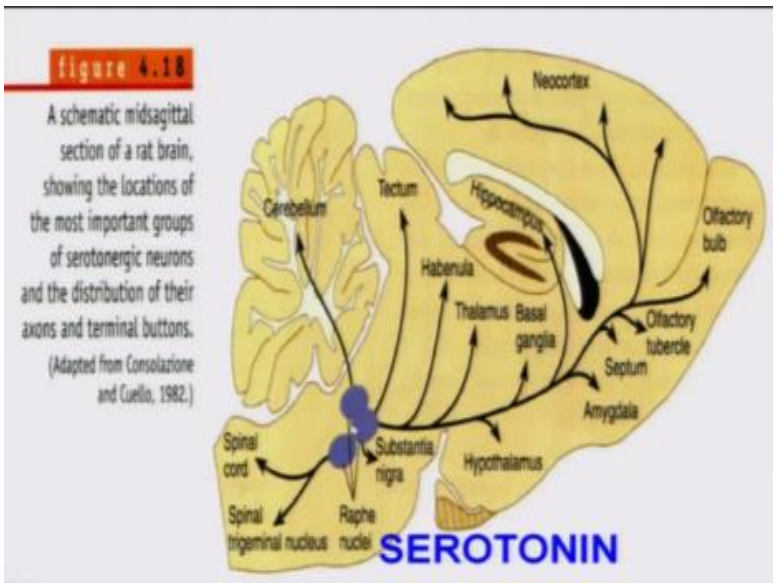
Like for example this is a Dopamine System, dopamine is one of the neurotransmitters. These areas are where it is maximally present.

(Refer Slide Time: 47:35)



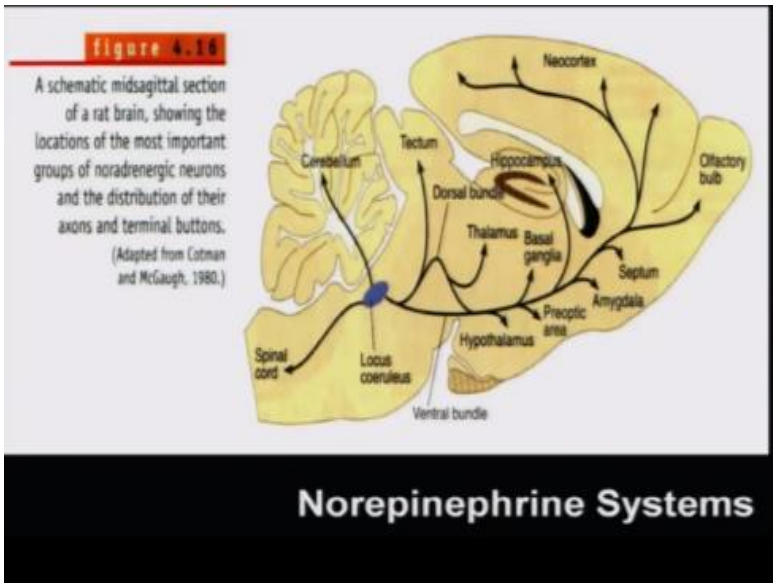
This is noradrenergic so these are the maximally concentrated cell bodies of this and then they have a widespread presence.

(Refer Slide Time: 47:45)



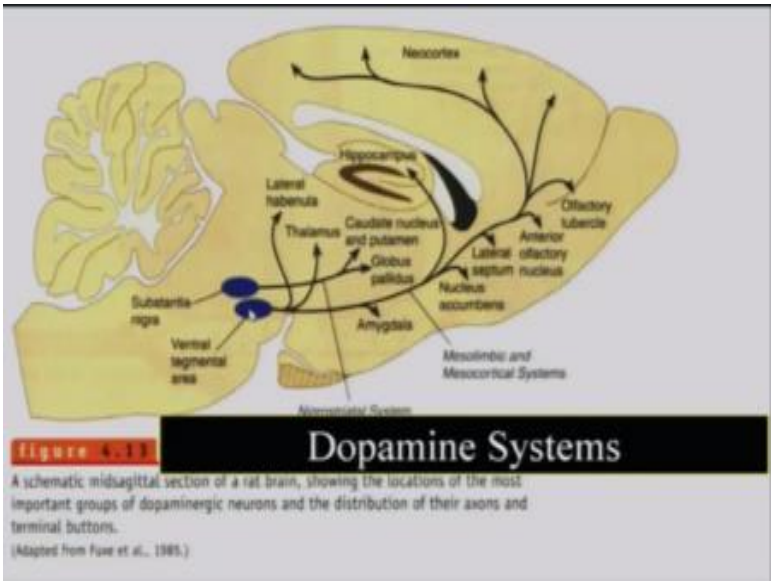
All over, this is serotonergic thing. You see a maximally concentrated air in raphe nucleus.

(Refer Slide Time: 47:54)



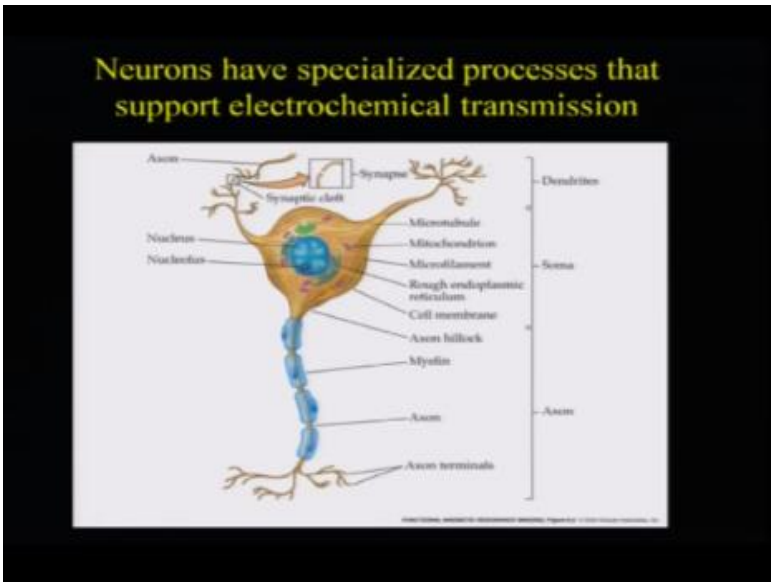
Like this is in locus coerules.

(Refer Slide Time: 47:57)

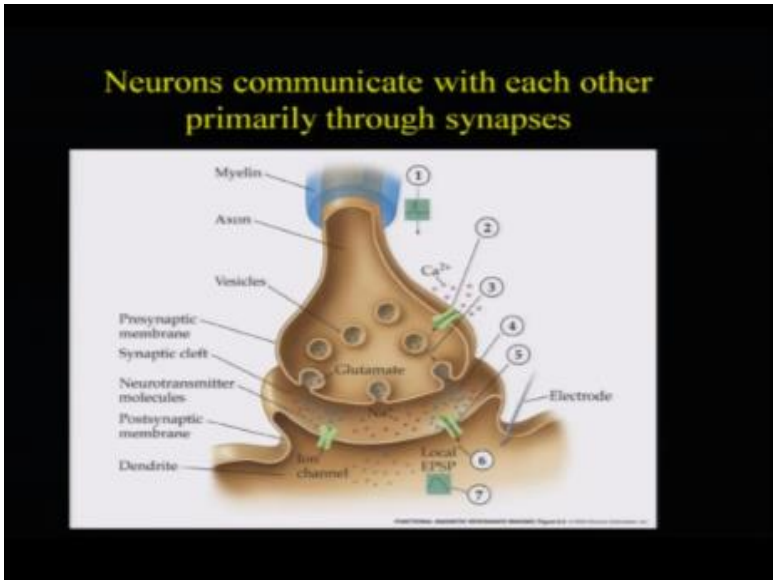


This is in substantia nigra. This is where actually the damage happens in Parkinson's disease.

(Refer Slide Time: 48:02)

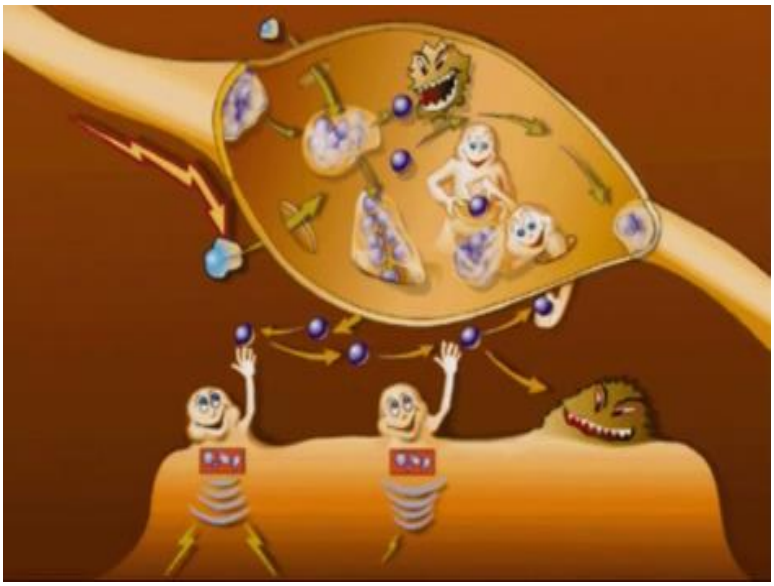


(Refer Slide Time: 48:02)



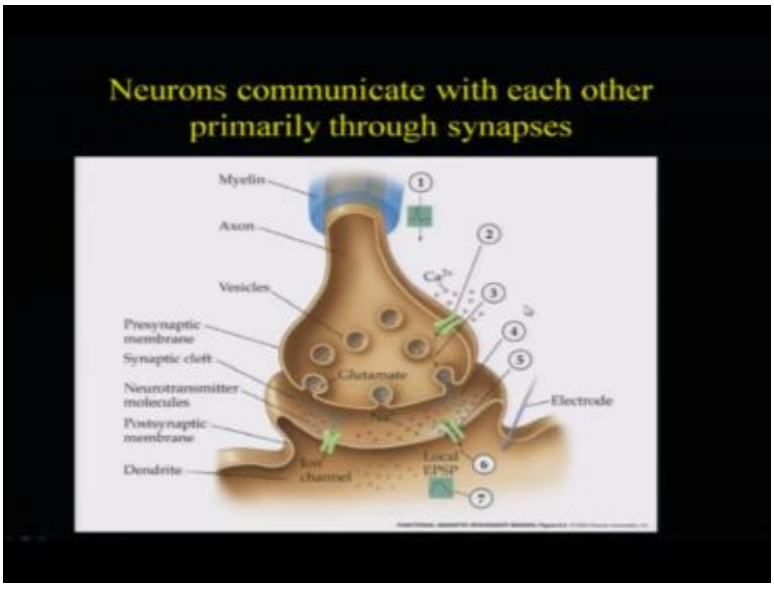
Now what is happening with this neurons, see the brain functions in.

(Refer Slide Time: 48:06)



With something called a action potential.

(Refer Slide Time: 48:09)



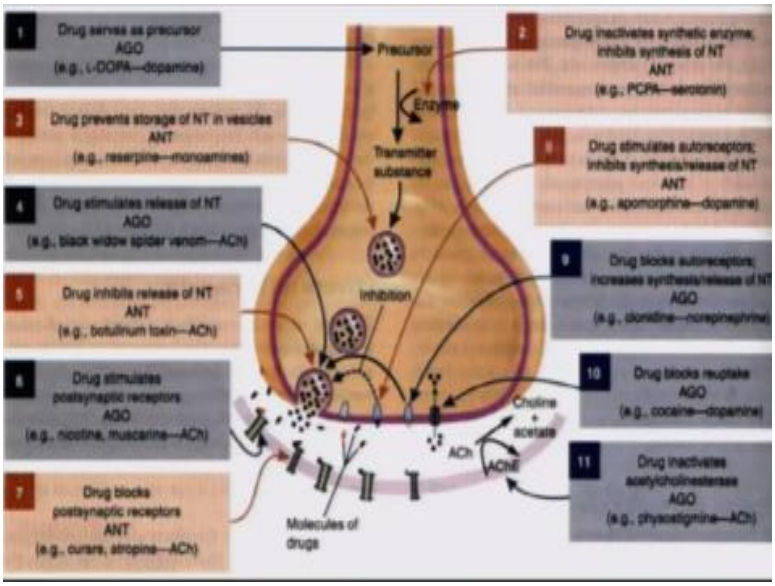
Action potential is that normal in normal condition the outside of the brain is positive and this is negative, with a difference of say -70 milli watts. When there is a signal which comes like this,

this chemical goes, this zero transmitter goes, by next to this protein structure called receptor. And it goes in, it either excites or inhibits. Excite means it will set in a current or it may be inhibitory that it may not set in a current. That is simply managed in the, simple to say but it is a very difficult process is that if there is a high level of sodium outside and potassium and chloride inside this will be positive and this will be negative, outside positive, inside negative. This is polarized state, but if a current comes suppose this binds air suddenly this will open, this channel which is normally closed will open, lot of sodium will rush in, this will become negative and this will become positive.

The outside becomes negative and inside becomes positive, so this is a depolarized state. So this set of current goes on like a wave. And this is called action potential, action potential is all or none, either the neuron is fired or it is not, it cannot go partial. But depending on, so once it passes the current passes through the whole neuron and it comes here again this will decide on what is being secreted. The glutamate is one of the excitatory so it will always go to the next neuron and excite it.

That means it will set in a current, like there is something call gaba, gaba always goes in inhibit that is one of the inhibitory thing. Now what is the importance of excitation and imagine this is, this we are just talking about one neuron, but does not happen with one neuron, when it is happening.

(Refer Slide Time: 50:24)

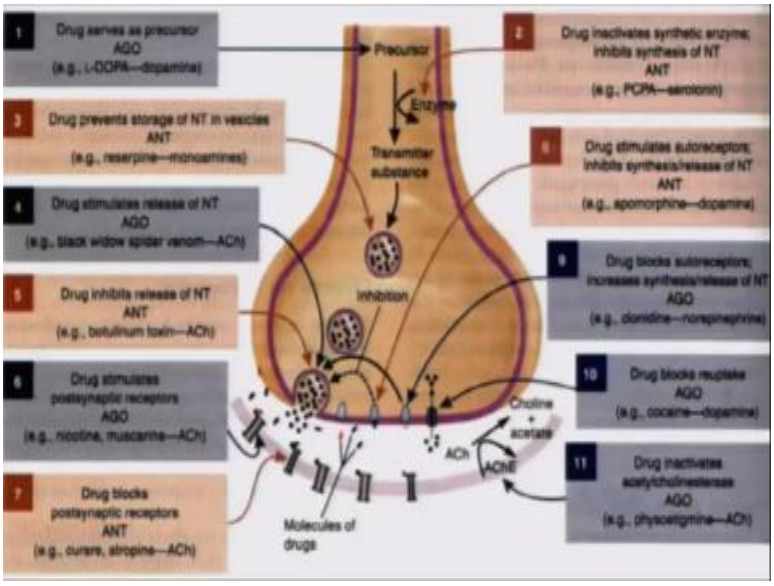


It is happening with millions of neurons which are secreting on one cell. So if millions of neurons are sending gaba that neuron the next neuron is not going to fire. Inhibition is important because inhibition controls the activity, because if it is all excitation all the neurons will keep firing and you can imagine the confusion it can cause and the conundrum which it will cause because brain has to regulate activity by controlling it.

So inhibitory neurons in, inhibitory neurons can also act in two ways, one that it will go and inhibit the firing with other neuron. Sometimes they can inhibit the one neuron which in turn will excite the other one. Like let me give you an example, like if it, if you say, you say there is a neuron one, there is a neuron one and there is a neuron two, there is a neuron three. Now neuron two inhibits the firing of neuron three, so it does not allow the neuron three to fire, so that means the functions controlled by neuron three will not be working when neuron two is active.

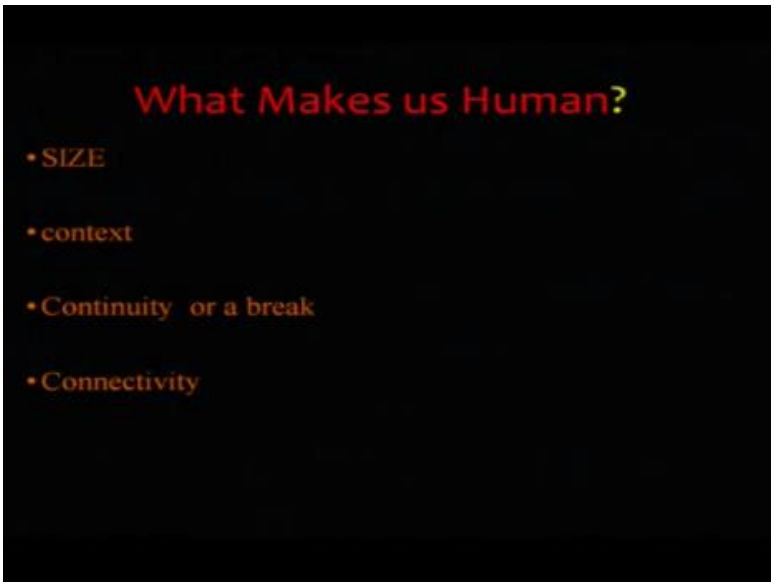
But if neuron one inhibits the neuron two the control of two over three will vanish for the time being and then three will start firing. So it is like a loop which goes on.

(Refer Slide Time: 52:04)



One neuron controls the other, it may get inhibited in turn by the other, and the functions controlled by its, the other control neurons may so it is a long feedback loop and there are centers in the brain which keep receiving this feedback loop to could decide about the further action. So, broadly this was how the brain is formed. And as I said this as we talk about physiology lot of this will become clear to you. So the basic question is still remain what makes us human?

(Refer Slide Time: 52:39)



Size, size of other animals, the brain of other animals is pretty high in some cases, context, continuity, or a break, or connectivity. So in the next lecture we will move on to how the brain functions and then we will, following that we will look at how do we actually try to peep into the brain. Thank you.