Animal Physiology
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Module - 1
Lecture – 4

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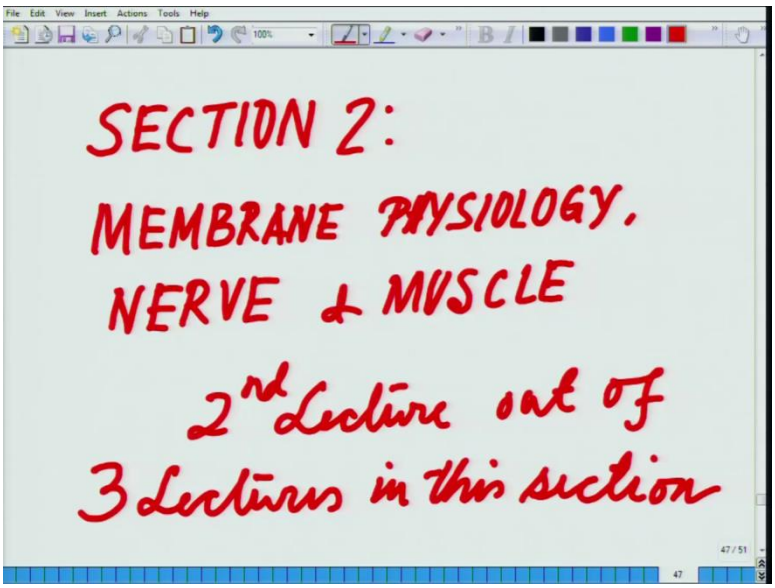

So, in this section 2, where we started with membrane physiology of nerve and muscle. We designated to have three lectures, so we are done with the first lecture where we talked about the lipids, which are present in the membrane in the classification of lipids and few other details. Today, what we will do in this part second lecture of this section? We will be talking little bit about the structure of the membrane and techniques which are being used. Before we move on to this lecture there is a small carry over which I missed out in the previous lecture. We talked about within the membrane we have the presence of the glycol lipids and the phospholipids. There is one more component which is present in the membrane and which has a very profound role to play that is called cholesterol. So, know I will just add that and then I will start this.

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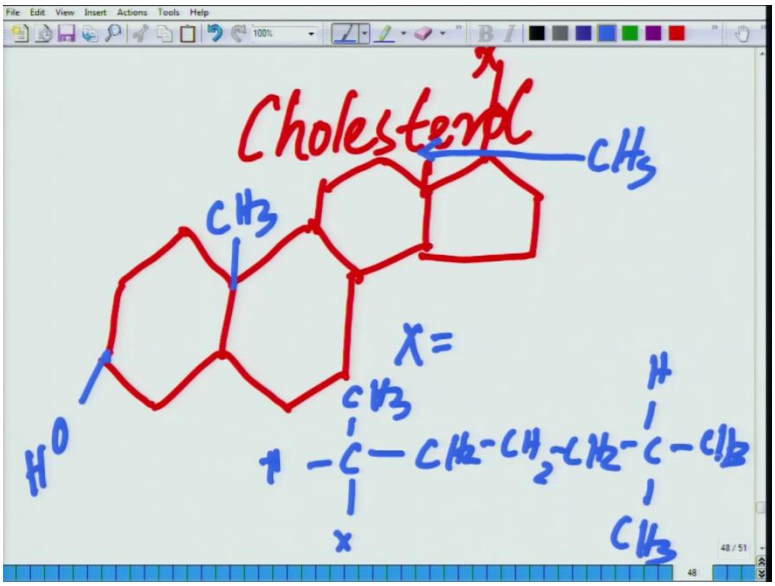

Today is section's lecture, what exactly is the cholesterol among the lipids is we talked about the phospholipids and a glycol lipids. So, this is the third moiety in that structure this is very profound important molecule in biology and the evolution. This is how the structure of cholesterol looks like it is a fairly big structure the x I will mention what the x is and you have one second you have 1 C H 3 attached here you have another C H 3 attached here. And you have a OH hydroxyl group attached here and this x equals to C C H 3 H and this is where the x is actually connected C H 2 C H 2 C H 2 C H C H 3 and C H 3. So, this is the structure of the cholesterol and in this lecture. We will come to see where cholesterol is playing a very important role in the fluid nature of the membrane. And what are its other physiological functions as I will work through the course. We will talk about it, where the cholesterol plays a major role with this small backlog which I missed upon. We will I will now numerate the topics which I will be taking up.

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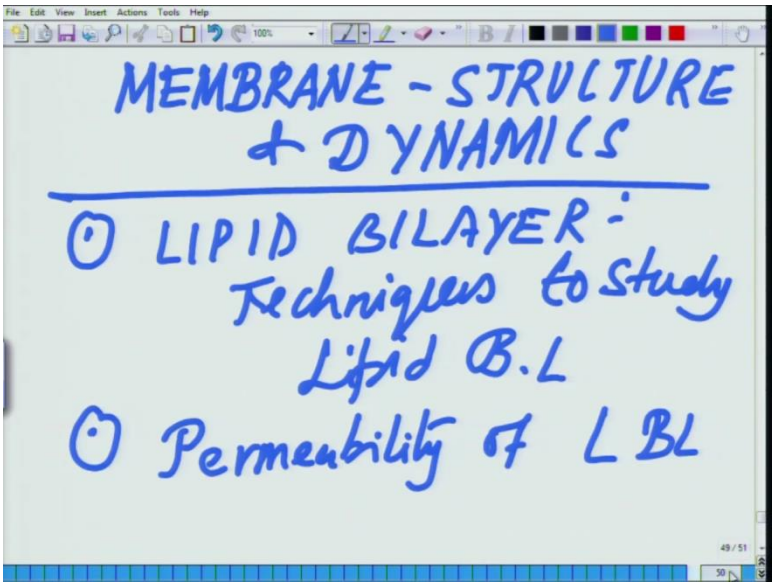

In this lecture there are 12 small topics which I will be taking up in this lecture under the heading of membrane structure and dynamics; so some of we have already covered around 10 topics in this structure and dynamics. The topics, which I am going to cover today in this section this concludes lipid bilayer. First topic; lipid bilayer and techniques to study bilayer this is the first topic I am going to techniques to study lipid bilayer just putting it as B L as shortcut then we will be talking about the permeability. This is the second topic I will be touching in this lecture permeability of lipid bilayer.

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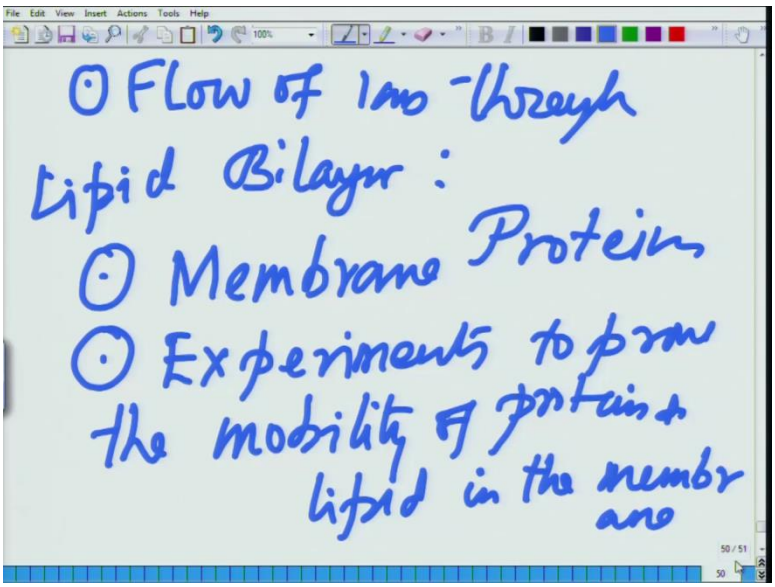

Then I will be talking about the flow of ions through lipid bilayer, and how this could be detected the fourth topic what I will be covering will be the membrane protein. The next topic I will be covering is the experiments to prove, if you remember in the last lecture I told you, I will be talking about the experiments to prove the mobility of proteins and lipids in the membrane.

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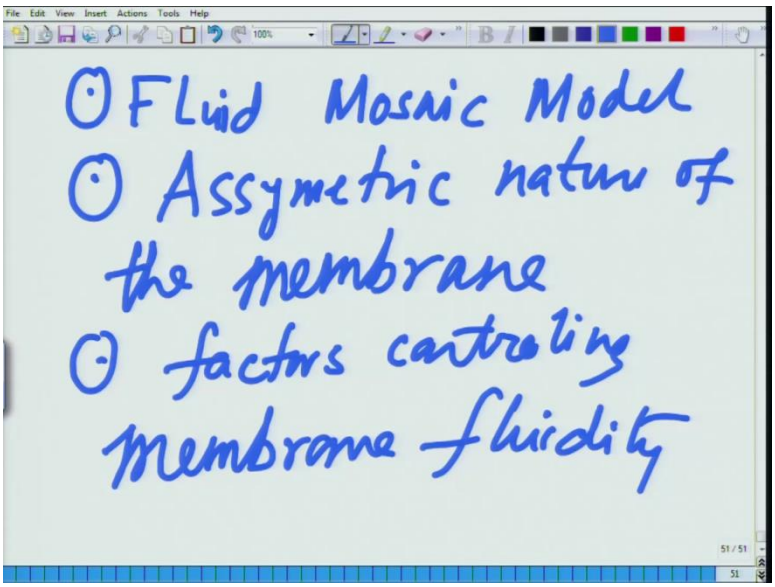

Next topic I will be talking about the fluid mosaic model of the membrane, then we will be talking about the asymmetric nature slightly more detail asymmetric nature of the membrane. Followed by that we will be talking about factors controlling membrane fluidity and this is where we will be talking about the role of cholesterol membrane fluidity.

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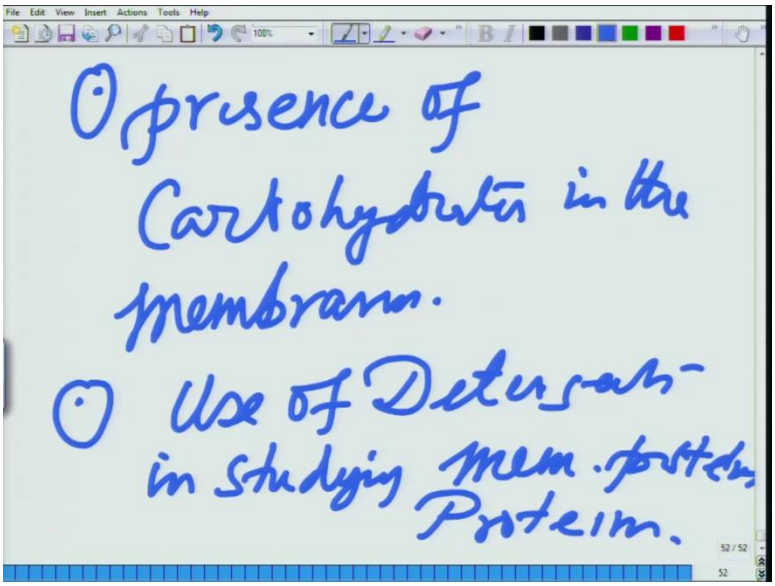

Then we will be talking about presence of carbohydrate in the membrane, and last we will be talking about the use of detergents in studding membrane proteins membrane proteins. So, these are the topic, which I am going to pick up in this sections.

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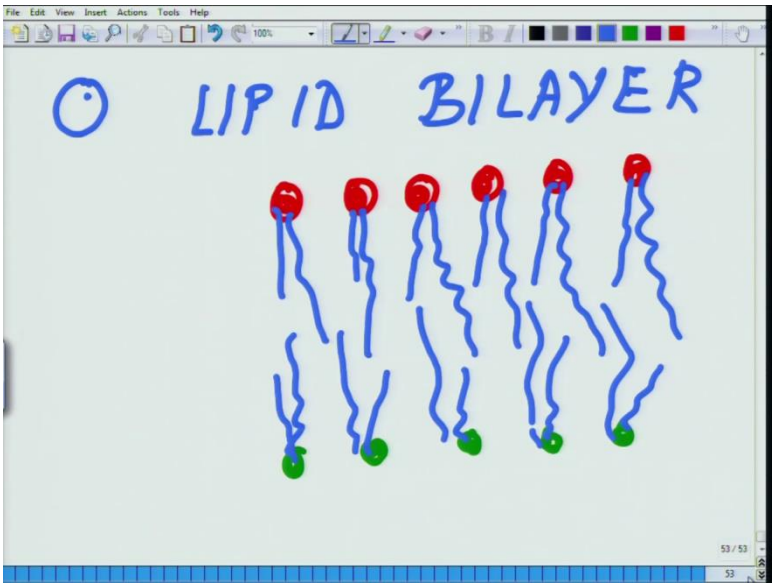

So, I said this let us talk about the lipid bilayer. So, in the last class I told you that lipid bilayer, the bilayer formation is directly related to the presence of phosphor lipids and the glycol lipids and now I have added the cholesterol. So, now what are the different techniques which we could used to in order to understand this? So, under this heading

will talk about let us draw the lipid bilayer. So, this is how it looks like I drew it like this. So, this is one side of the lipids this is the other side of the lipids and here you have the hydrophobic chain. So, is there a way how we can recreate this lipid bilayer in the lab. So, this is there are 2 different ways how you can do it. So, we will be talking about one of the techniques first which will help you. So, that is basically fall under the preparation of lipid vesicles in order to study the lipid bilayers. So, how it is being done?

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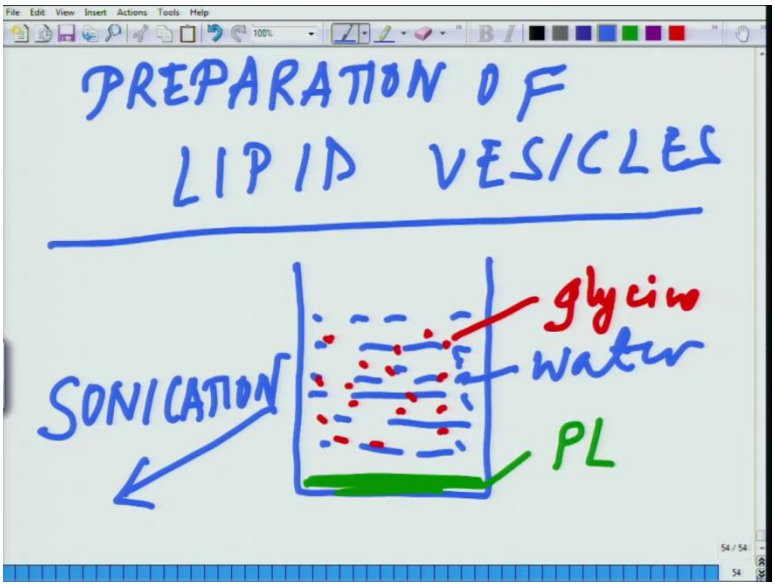

Preparation of lipid vesicles; so what is generally done in the labs is that it take a beaker like this. In the beaker you have a layer you make a layer of phospho lipid. Let us put the phospho lipid see it is in green is the phosphor lipids P L on top of that you add water likewise. And you can use any kind of this case I am adding these are small amino acid called glycine. And this is water what you do with this you sonicate this sonicate means you agitate it at a very, very high sound frequency sonication.

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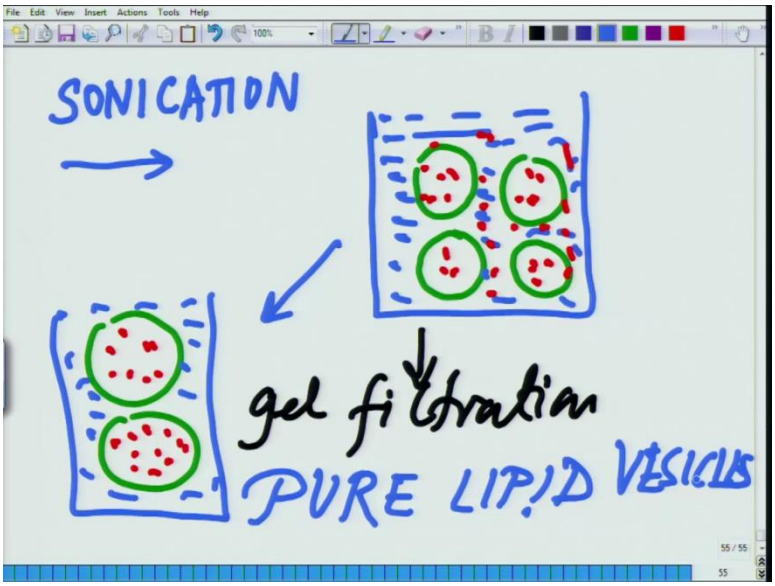

So, once you sonicate it. So, let us follow it following sonication you see it forms something like this, let me just check what is the color code I used fine. So, post sonication what you see say these kind of which are formed and this is the water all over the place outside and within that you see the trapped molecules of glycene and there are some glycene which are present outside. So, from here what you do you a simple technique called gel filtration and following gel filtration what you obtain are pure lipid vesicles. You get rid of all the glycene from suspension and there are glycenes which are trapped inside the, lipid vesicles here water this is how you create the lipid bilayer. This is one such techniques of creating pure lipid vesicles. And you can use the kind of which so ever phosphor lipids you can use instead of phospho lipid some mixture of glycolids. It is you can use cholesterol, you can vary the concentration of cholesterol you can do several things in this situation.

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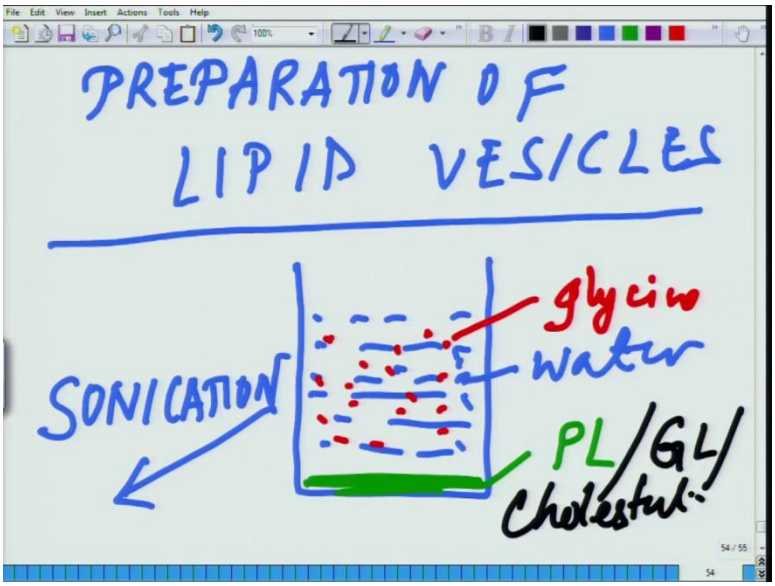

Which will help you to do different kind of vesicles, there is another technique, which is slightly more advanced technique that is called one second that is called.

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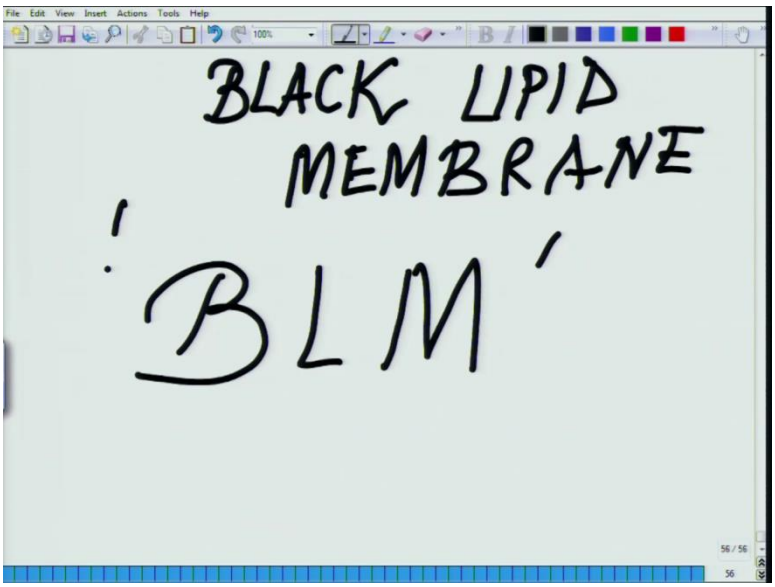

Black lipid membrane technique of studying lipid bilayer black lipid membrane. In short some time it is also referred to as BLM technique black lipid membrane apparatus. So, what really black lipid membrane apparatus means.

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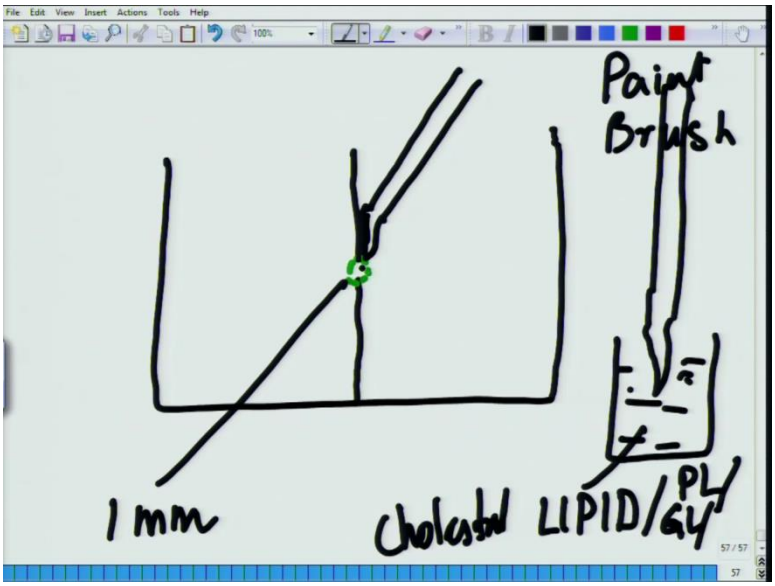

So, just imagine you have 2 beakers like this you have a jar where there is a small partition fine, and within that partition you have a hole like this sorry let me redraw it like this now, what you do? So, you see small hole out here let me mark this hole for your understanding. So, this is where the hole is what you do you take a paint brush all of you have seen paint brush, take a paint brush like this and dip it in this is the paint brush. And the dimension of this whole is approximately 1 milli meter you take the paint brush and you have the lipid solution here. It could be a phosphor lipid PL it could be a glycol lipid it could be cholesterol what is ever and you take the paint brush out here this is the way you do it like this you rub the paint brush out along that hole. So, once you do, so what will happen?

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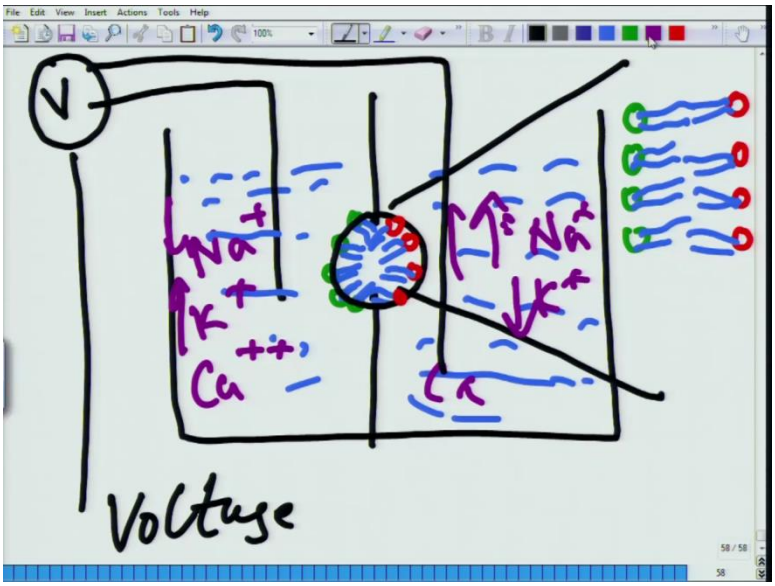

Is this if I redraw this and here you have the gap it forms a lipid bilayer here. So, something like this, what will you see if I observe it under the microscope? It will look like this on either side it will be like this. So, in other word you form a membrane across that hole something like this; this is what is going to form here if I redraw it on top of it. It will be like this just for your simplicity sake I am following a color code, but it could be all mixed up something like this. Now, what you do is you fill this side with water and you fill the other side with water and you add different kind of solutes into this say for example, you add sodium, potassium, calcium.

You do the same thing at different concentration calcium plus plus sodium plus potassium plus at different concentration. You can have sodium potassium higher on one side potassium lower on other side here. I have sodium higher on one side potassium on other side and then you can test is actually. You can connect it with 2 electrodes you have electrodes like this and. You have another electrode which is like this and these electrodes are like connected to some kind of volt meter which will measure the voltage or you trying to some other gadget which could measure the voltage. So, any kind of mobility of the will go to the next slide.

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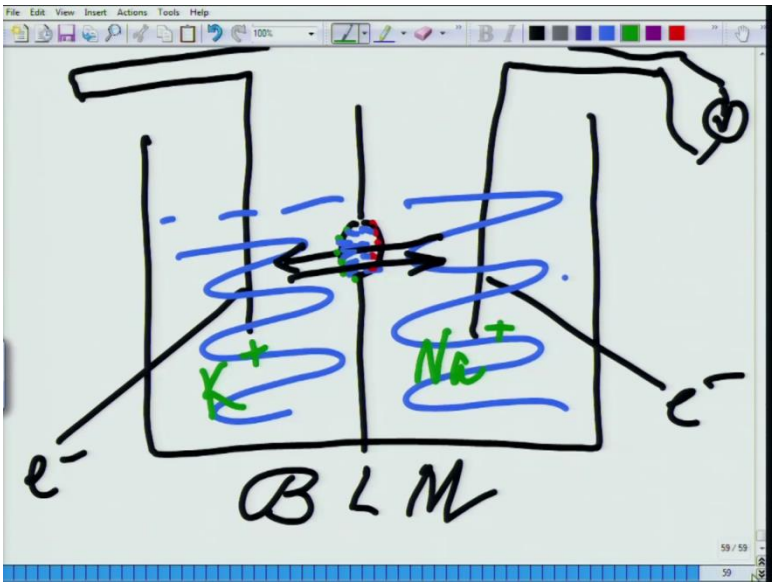

So, that it is not crowded for you to understand, so here you have the bilayer already formed. And here is the electrode on one side here is the electrode on another side and this is all connected to some kind of measuring device. So, this is the electrode this is the electrode and this is that hole where that liquid bilayer is formed, and here you have the fluid with all the different ions. So, any kind of movement of ions across this could be recorded by this voltage sensor or current devices which are present there. So, this is how the black lipid membrane. So, where is useful in understanding the movement of any kind of ions or any kind of molecules across the membrane.

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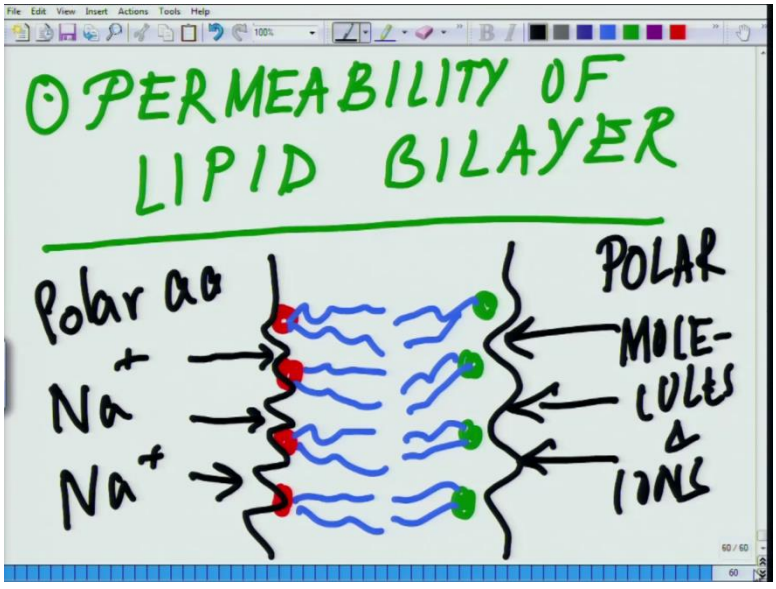

So, this is one of the technique which are being used from here we will move on to the permeability of the liquid bilayer this is very important this is the second section topic of the section permeability of lipid bilayer. So, one of the fundamental thing about the lipid bilayer is that these are highly impermeable to ions and most polar molecules the molecules which are having some form of charge out there or some form of iron like sodium potassium. They are exceptionally permeable; they cannot really directly pass through the membrane. In other words, what I mean is this say for example, you have a lipid bilayer like this and something like this.

And you have this, it is very tough for these kind of ions or some kind of polar molecules you know some kind of say polar amino acids which we have already talked it is most unlikely that it can pass through. If this will block the movement of these polar ions from either side whichever way you tried it is going to block the entry of the polar molecules. So, the polar molecules or the ions polar molecules and ions are very, very impermeable to the lipid bilayer.

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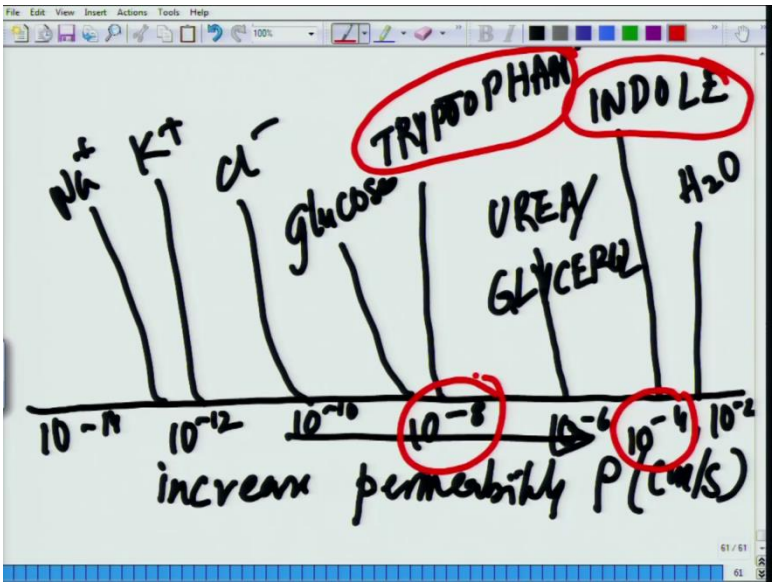

And if I kind of draw a kind of scale of about the permeability of different component through the lipid bilayer in terms of the increased permeability. If I have something a scale like this increasing increase permeability unit will be permeability in centimeter per second. That is it then if you look at it 10 to the power minus 14. Let us put in the values10 to the power minus 12 10 to the power minus 10 likewise if I move 10 to the

power minus 2 10 to the power minus 4 10 to the power minus 6 10 to the power minus 8 10 to the power. I can just rub this scale10 to the power minus 8 if this is the permeability values I am. So, you will see the most permeable will be water then you have something in around 10 to the power 4 here you have something molecule called indole which is very similar to another molecule which come very soon.

Then around 10 to the power 6 you have urea which is more permeable urea or glycerol then around 10 to the power 8 you have tryptophan. Tryptophan is one of the amino amino acids and around 10 to the power about 8 is glucose then comes around 10 to the power 10 is chloride ions 10 to the power12 is potassium ions and near about this is the sodium ion, which is very least permeable into the game. And if you look at this figure just traces a very simple question how come this tryptophan which is very similar structure as compared to indole very, very similar structure how come indole is more permeable as compared to tryptophan.

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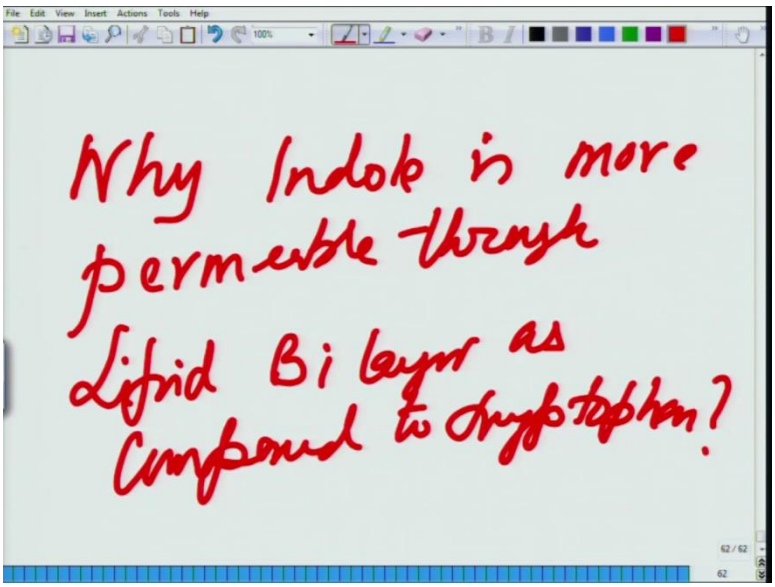

So, in other word the question is why? Indole is more permeable through lipid bilayer as compared totryptophan, this is 1 question I will leave for you people to think over it. What is the difference between the 2 structure which makes tryptophan less permeable to lipid bilayer as compare to indole. though their structure is very, very similar? And your answer lies in some of the polar nature of it as I mention in this small section that polar molecules or the charged ions or the ions are very less permeable across the lipid bilayer.

Now, the question arises a very serious question now arises what makes anion or polar molecules to pass through there must be some way. Because as we have already seen the previous scale that most of them most of these are not that very permeable.

And this is where comes the role of proteins or the membrane protein this is where comes the role of ion channels ion channel proteins which are very very significant area of research. There is a huge amount of budget which has been allocated by national institute of health of United States and several other countries to understand the structure and function of ion channels. And we will talk more as we will move in through the course here comes the role of pumps. So, these are those proteins which are embedded within the lipid bilayer which allows the flow of polar molecules ions.

And many other molecules which directly cannot pass through lipid bilayer or the permeability is very low. And with that permeability no philological function can take place. So, now, we will in order to understand this will talk before we get into any kind of membrane protein which are very, very complex structure and very little structural information about it is available currently very few are very known in at a very low resolution crystallographic structure. We will talk about some simple molecules which have the ability to form channels or pores along the membrane. So, this section falls under transport antibiotics as carriers or channels.

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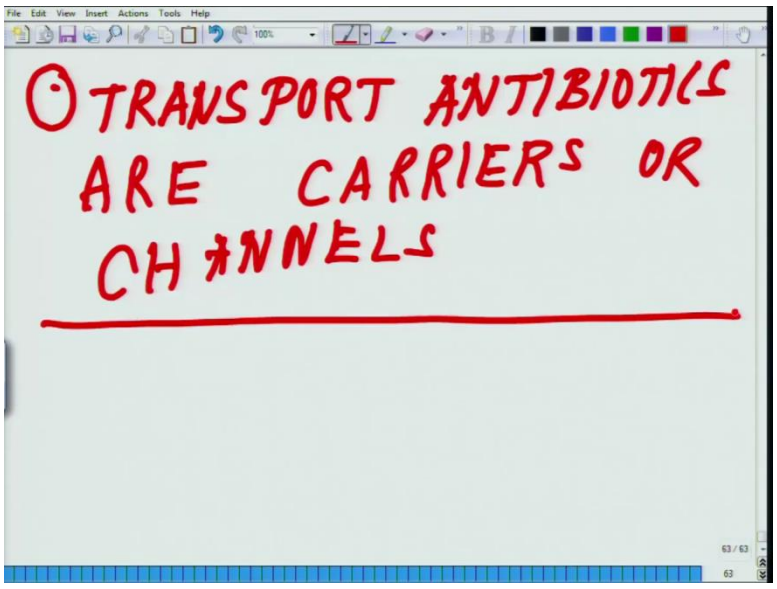

This is what we are going to deal with transport antibiotics are carriers or cannels. So, talking about this let us move on to the next slide.

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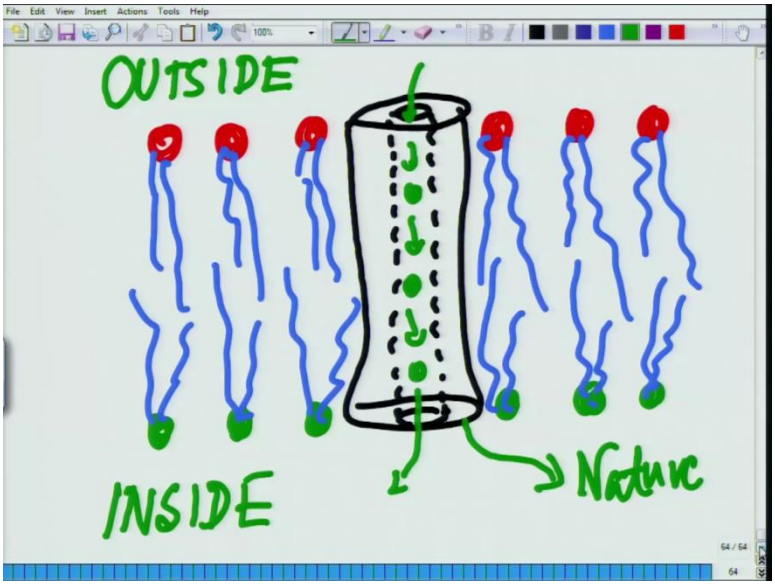

Let us redraw the membrane again these are the polar head groups in red and another set of polar head groups, which are facing inside the cell like this and here is the hydrophobic tail and keep on repeating it. So, that it kind of engraves into your thinking and understanding. So, I am kind of continuously repeating all these things for you guys. So, a membrane protein or anything which has to form a passage has to stand like this.

It has to form something like this, structure like this which has a may be an inner code like this through which any of the molecules can pass through something like this; this is the molecule which is passing through. So, this is outside and this is inside. So, what are those nature of these kind of molecules? This is where we are going to talk about some of the smaller ones simplest one before we get into the one which are forming fine channels and everything. So, one such example is carrier transport antibiotics are something like this.

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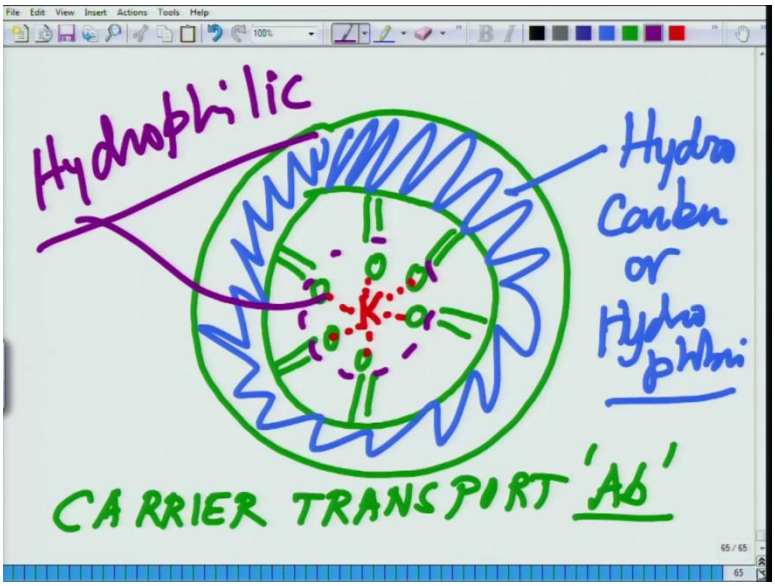

This is one such carrier transport antibiotics which has hydro hydro carbon periphery, and within the hydro carbon periphery it forms it has something like this. So, this is called carrier transport antibiotics. I am just putting the short form antibiotics as A B. So, you people understand these are the oxygen molecules and in the center you have potassium and potassium ion form coordination complex with 6 oxygen there. And this is the zone, which is this is hydro carbon or hydro phobic part of it and this part what you see out here is the hydrophilic core. So, these kinds of molecules when they get inserted inside the membrane. So, it is something like this again I have to draw the structure.

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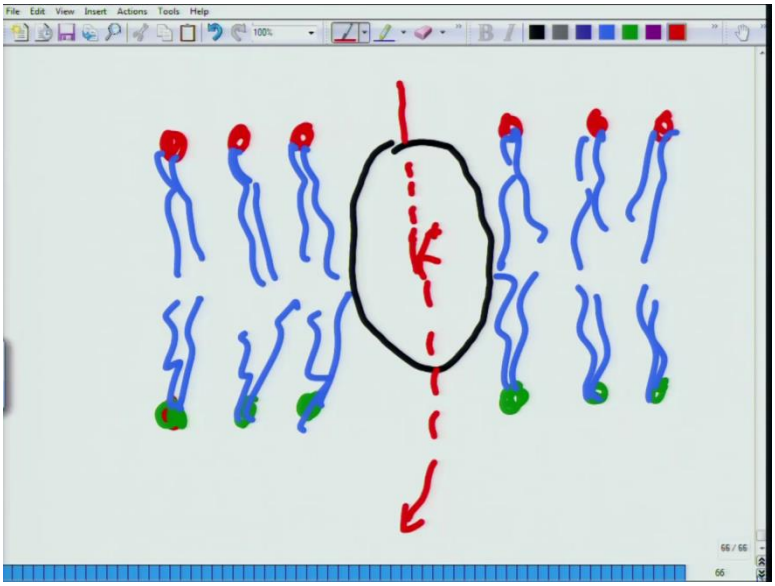

So, that will make sense or the membrane and… So, this is where this kind of molecules get inserted into the membrane and here they have this potassium core through which any kind of water or any other any other ions can pass through or any other molecules can pass through. This is one such example which is carrier transport. So, there are other example which will be talking about it, one of them is one of them is your valinomycine.

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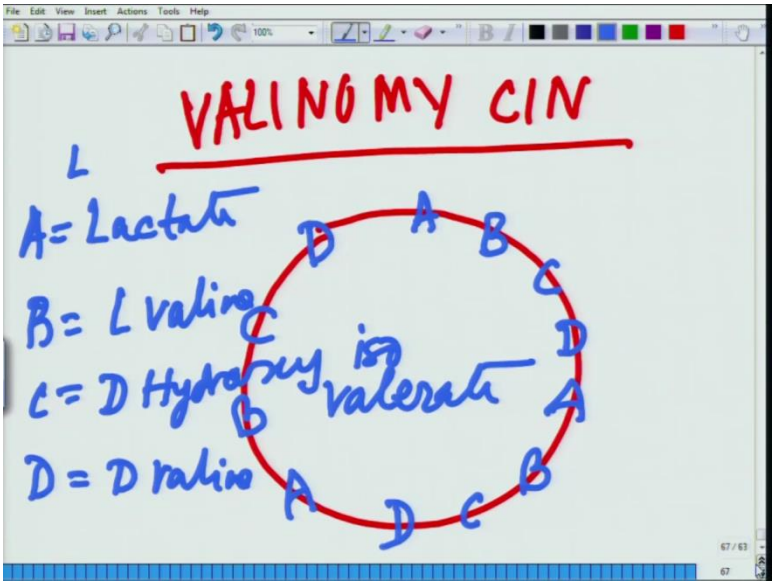

This is this is another cyclic molecule something like this let me put all the residues then I will tell you A B C D and this A B C D stands for different residues I am going to come to that A B C D this A B C D A B C D. So, sum total there are 1 2 3 4 5 6 7 8 9 10 11 12 there 12 such residues where a stands for l it is an l isomer l lactate, b stand for l vilene c stand for de hydroxyl isovalerate d hydroxyl is o valerate and d stand for d Vilene. And if you if go through the structure of it, it is something like this.

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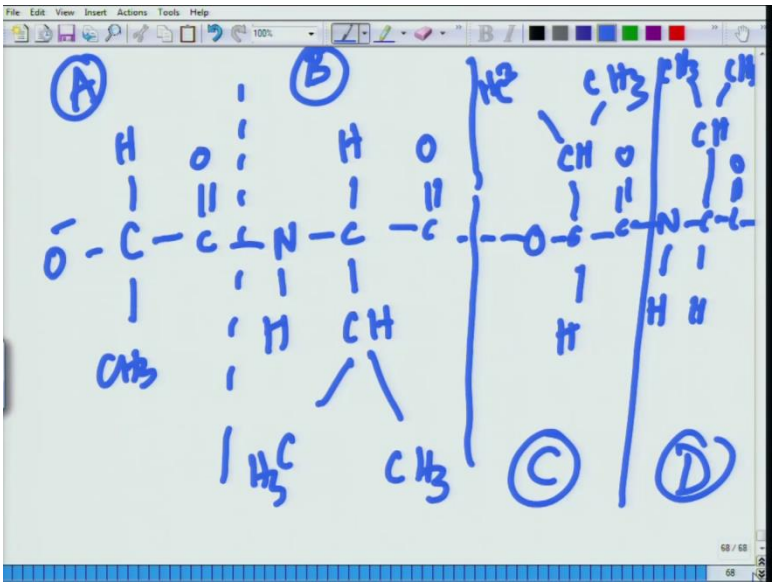

C H O minus C H 3 C double bonded with O. So, this is A, so now B B is N H C H and you have C H you have C H 3 you have C H 3 here and you have a C double bonded with O and this is your B. Then you have the C molecule which is oxygen C C H C H 3 C H 3 C double bonded with O H this is c and there is another one here N H C H C double bonded with O C H C H 3 C H 3. So, this is D and is C. So, this is how it is being connected in the valinomycene and when this valinomycene molecule I showed you that then A B C D.

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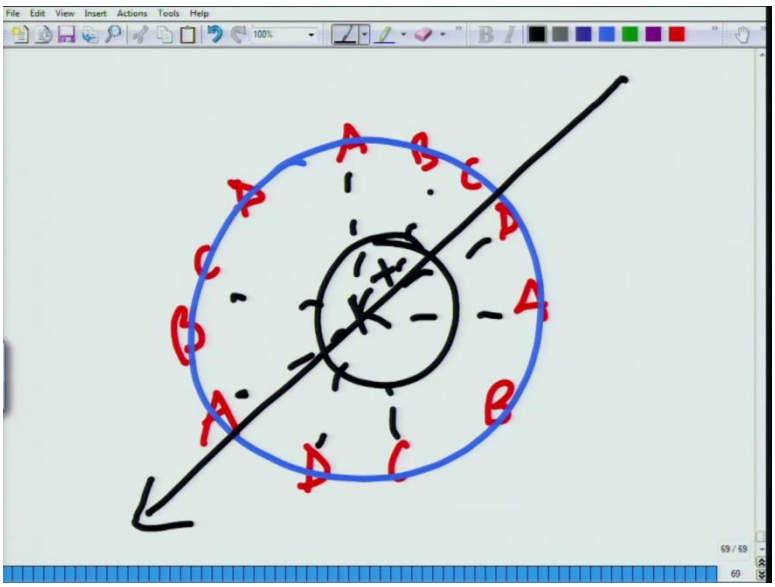

Likewise let us see A B C D A B C D and then again A B C D and within the center of it what you observe is very interesting. Again there is an potassium which is present in the center and which is kind of coordination complex and this is potassium which is there which allows ions to move through it.

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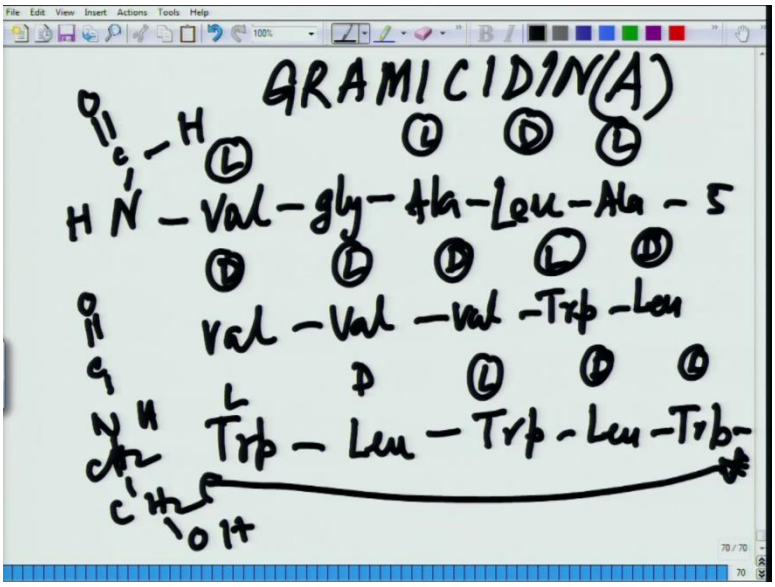

And in the same line there is another molecule there are kind of the classic molecule which have been used all these years is called gramicidin A gramicidin A is another such channel forming molecule. So, gramicidin is much more complex structure of put the structure for you guys get any kind of feel you these kind of get these are the small structure these are easy to understand before we understand. So, this is and alternate L and D isomer of amino acids. So, this is the L isomer glycine then you have the alkaline which is the L isomer here then you have I kindly request you people to kindly go through the structure of the amino acids form the notes. From alkaline this 1 up to 5 and you have the valene which is in D conformation and you have another valene which is a L conformation. Here in another valene which is in D conformation, you have tryptophan which is in L conformation you have Lucien which is in D conformation.

So, you see there is an alternate L and D and then you have tryptophan which is an L conformation you have Lucien which is in D conformation. You have another one which is in L conformation you have Lucien in D conformation. You have P in L conformation and then it is attached to attached to a carboxyl group and N H C H 2 C H 2 O H. So, this

is how the gramicidin molecule looks like, and all these molecules have alternating L and D isomer and they are the one which form the channels. And these are some of the probes much before the membrane structure could be derived and it was a very challenging task. These are some of the molecular probes by which ion channel structure have been studied for several years and now also they are being studied. These are small molecules they act as antibiotics they act as toxins there are series of them. I just picked up 2 or there examples like valenomycene gramicidin and carrier antibiotics which will help you to appreciate how the membrane must have developed. So, from here we will move on to the fourth topic of this structure which is the flow of ion through.

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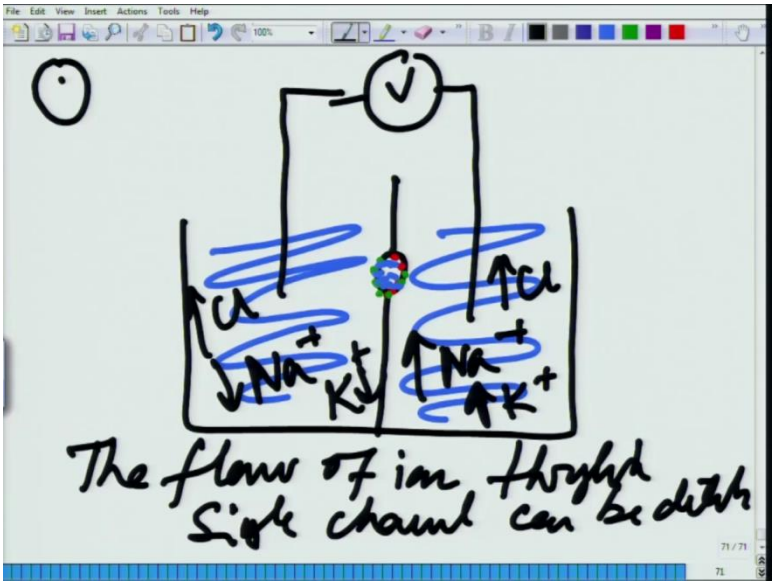

So, I told you I showed you the diagram in the beginning of the black lipid membrane. So, say for example, so let me redraw it. So, you could recreate the membrane like this and here you have this lipid bilayer formation. And here you have the and here you have the electrodes and at very high gain amplifier to record for the change in voltage across it and. There are different concentration across sodium say may be high; on this side sodium as may be low chloride may be high here. And chloride may be high here or say for example, potassium may be low here potassium may be high here, what is ever the flow of these this could be the flow of ion through single channel in a membrane can be detected. So, basically through single channel can be detected, how it is being done it is very straight way. So, I showed you that using a brush go to the next slide. So, you use a brush to create that membrane structure.

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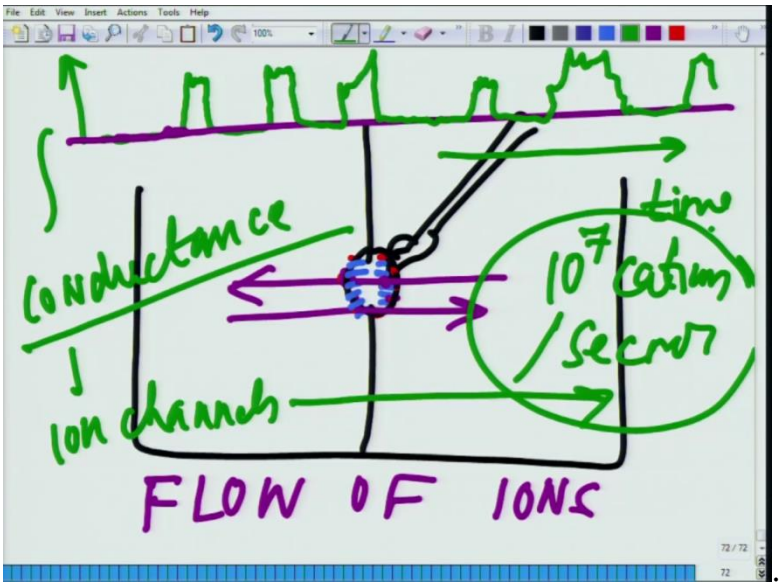

So, along with that brush you mix some of these some of these channel forming peptides of channel forming molecules. So, what will happen is this now out here you have you have some of the channel forming structures which will form, and they will allow the flow of ions across either one of the sides. That will help you to record the flow of ions through those channel. So, this is how most of these channels have been studied and recording kind of comes like this; this is the base line and you will see something like. So, this is when it is going up is basically the channel getting open. You can measure the density of the channels and you can know the whole bunch of complex experiment.

And you can understand how the channel looks like, where x axis is showing you time and y axis is showing you conductance. And we will talk more about it about the single channel recording. As we will move through go to the ion channel, where we will be talking about some of the fundamental discoveries ion channel recordings. Which were done by Irvin nehar, Albert sack man, Alan martei and all these other people which won them a Nobel prize and many other things. But just for your interest I can tell you that across these gramicidin channels and everything, almost 10 to the power 7 catine could travel per second.

This is almost the rate of migration which is the huge number. So, with this will move on to see will kind of give you an introduction about he how probably the bigger structure. We are talk about very, very small structures very, very small structures which are

forming channels think of it a huge protein like structure how it will look like. There are several conformation and geometries of how it looks like. So, let us draw the structure of the membrane to tell you how the proteins look like.

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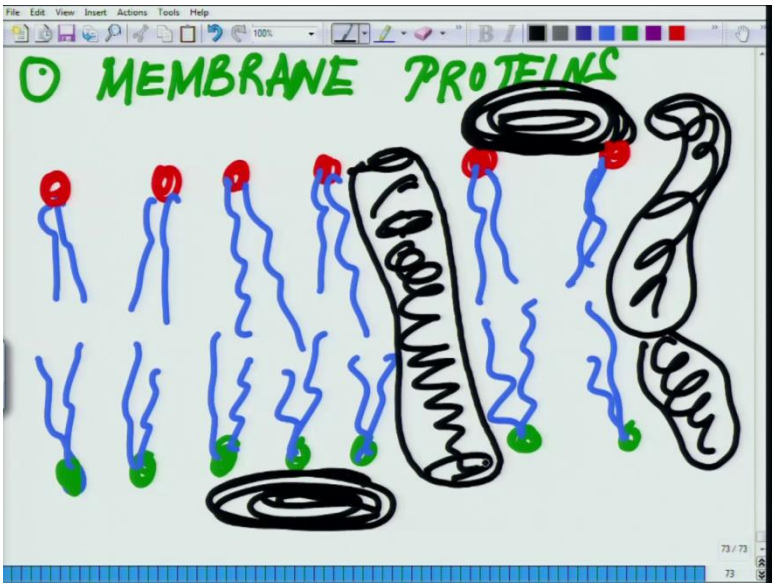

So, now we are entering into the area of membrane proteins, which are embaded within the lipid bilayer. So, let me again redraw the membrane sorry. So, proteins I will draw it in black to give it an understanding some of the proteins span like this, from the one side to another side. They are like this yet there are proteins, which sits on top of it like this like this e. It could be on a outer side it could be on a inner side both sides. Yet some of the proteins just have something like this one part may be attached to another part like this.

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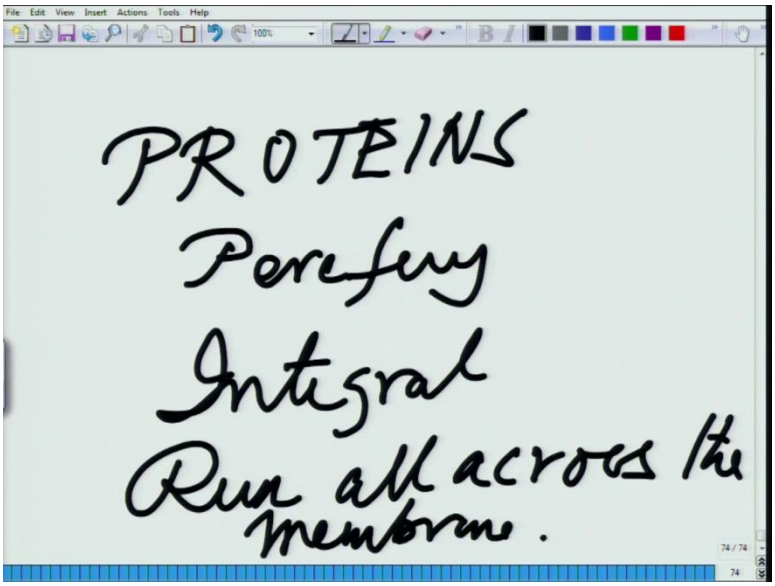

So, this is how all these different kind of proteins are sitting all along the membrane structure and these proteins these proteins could be your could be on the peripheral side on the periphery. It could be integral protein it could run all across the membrane run all across the membrane. How these things were discovered that is very important for you people to appreciate. So, there are certain techniques by which this have been done, there is a technique called freeze fracture etching technique. So, what you do say for example, let me take some say for example, this is the bilipid membrane just think of my purse as bilipid membrane. So, let me see how I orient it. So, imagine underneath is inside the cell and up its outside the cell. What I do I take this stuff and I what I do I freeze it down. Freeze it down at a temperature of say liquid nitrogen exceptionally cold temperature I freeze it down as soon as I freeze it down this is what will happen let me pen let me a membrane.

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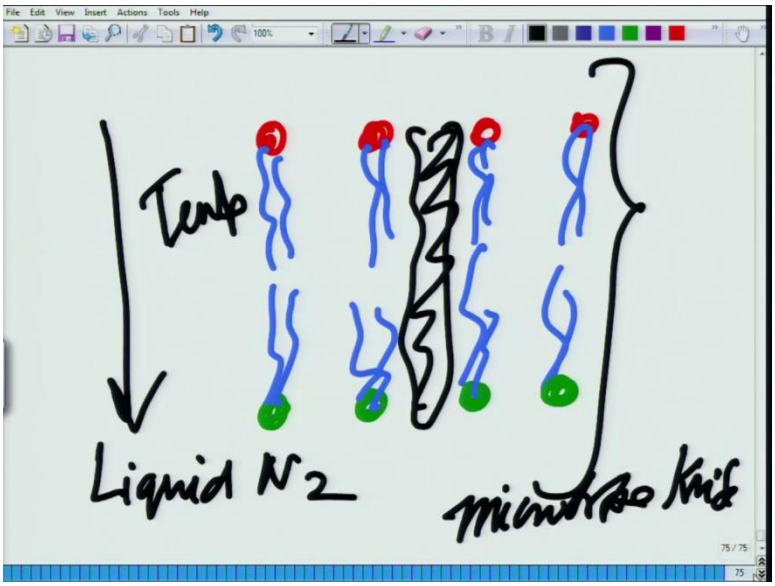

So, this is your membrane structure what I was trying to show you so and here is your protein of choice. So, now, I bring down the temperature to liquid nitrogen temperature. So, temperature is of liquid nitrogen and then what I do is at this stage I bring a sharp knife which is called a microtome microtome knife.

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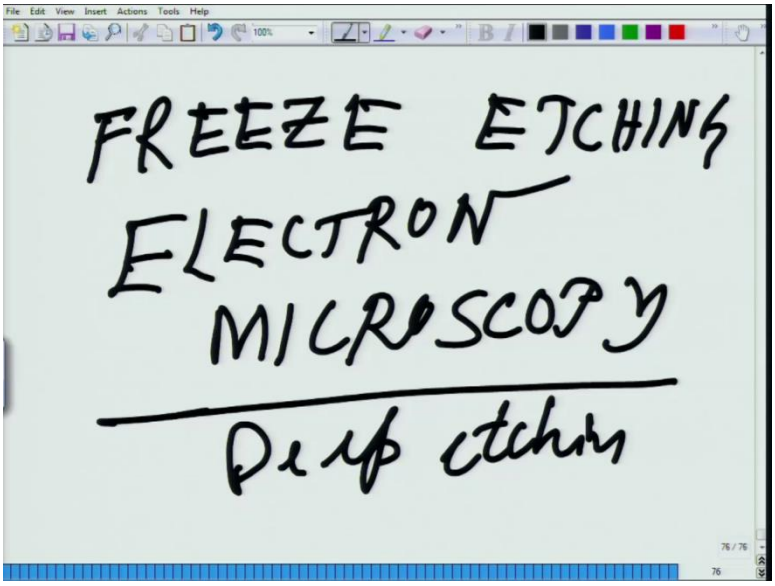

And I cut the membrane split up the membrane, and this is called basically the whole technique is called freeze etching e t c h freeze etching electron microscopy. This is how

it will discovered the they are integral protein which run from one side of the membrane to the other side of the membrane electron microscopy. And what you get out this is that doing this deep etching is something which I will show you through the purse using my wallet. So, say for example, this is outside and this is outside and this is the lipid bilayer leave this. So, when you put this at liquid nitrogen temperature and you cut it. So, you take the knife say for example, let me see. So, say for example, this is the knife I take the knife and I cut it through like this or I cut it through like this. What you will see is that it opens up like this, and this is exposed in front of the microscope in electron microscope and there you could see if there are some proteins which are my fingers are the proteins which are there.

So, I can see the structure of the proteins. So, this is how it is being done. So, this technique is called freeze etching electron microscopy and it follows a deep etching process. So, this is how most of the, these integral proteins have been covered that they run from 1 side 1 end to the other end of it. So, this is one such technique which I which to expose you people. So, from here we will move on to another technique you remember in the last class we talked about that we talked about that that lipids can move across the membrane laterally and very rarely do a flip flop movement it is really tough for it to do. So, how it has been proved I told you that I will I will give you some of the techniques by which membranes have been studied. So, one such technique is like this say for example. So, let us put the title.

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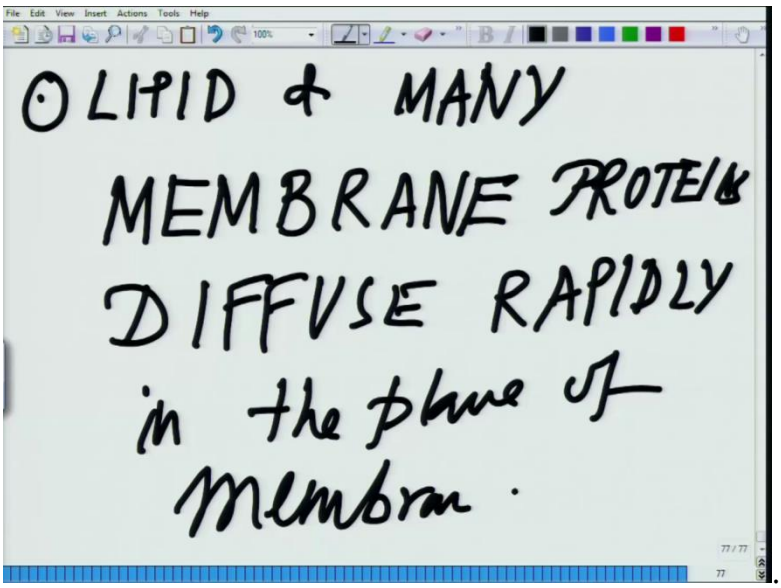

This is in this section we are talking about lipid and many membrane proteins membrane proteins defuse rapidly in the plane of membrane. So, how to prove this? So, we need experimental proof to do, so this is how it bring down.

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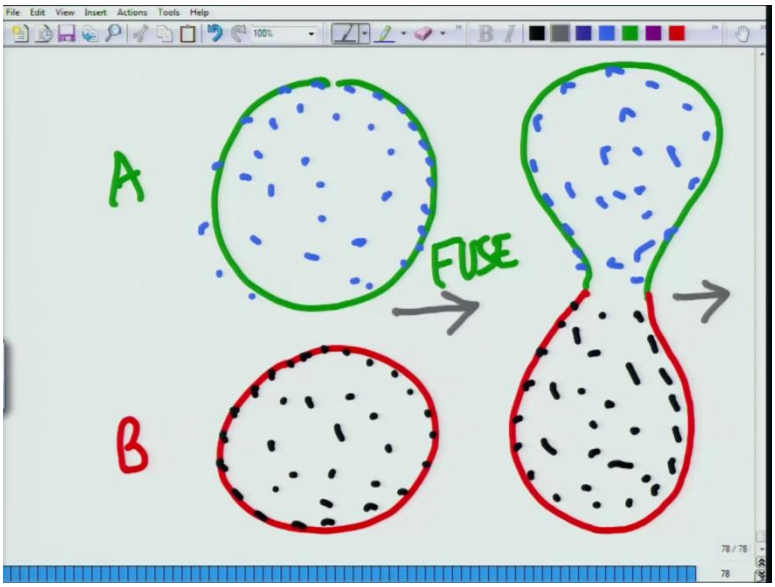

Say for example I have one cell a say for example. Cell a like this and I have another cell let me put it in different color b like this these are the 2 cells and on these 2 cells. I have some kind of a tagging of the lipids and the proteins say for example, these are the tag these blue colors are the tags and the other 1i have this black tag. So, the blue tag and we have the black tag the next what I do is let me pick up another color to explain it easily I fuse these 2 cells if I fuse these 2 cells. So, the structure will form like this I am fusing these 2 cells ones, I fuse these 2 cells. So, what will happen this black will remain here, and all the label will be here after some time what really observed is this.

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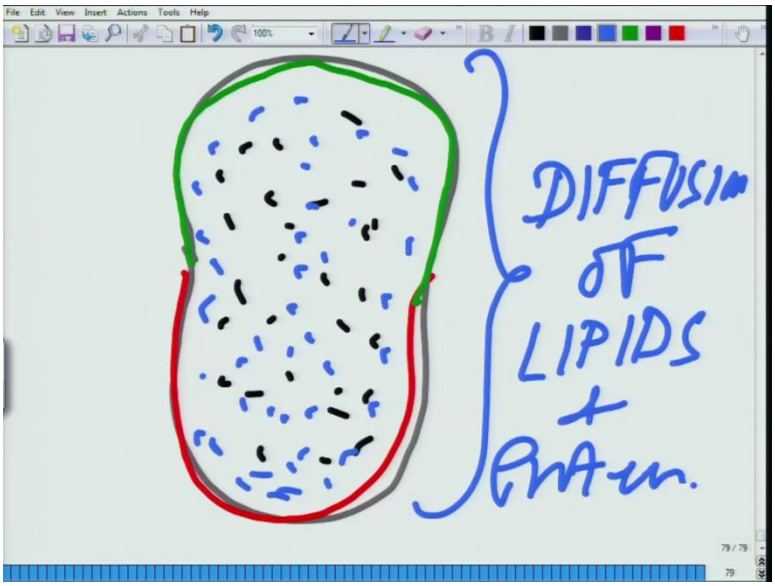

After if you give it some time and you observe the new structure, which is almost this big and if I give the will color something like this you know. So, let us check me through green and red fine green. So, if this part is the green one and this part is the red one what I will see is all those black dots and all those blue dots have mixed together likewise. So, that is one of the indirect proofs or kind of a crude proof to say these proteins and the lipids are moving all across the membrane, there is another way to prove it which is much more quantitative. So, this diffusion, so this diffusion takes place. So, there is a diffusion of lipids and proteins, there is another way to do. So, that technique is much more much more quantitative.

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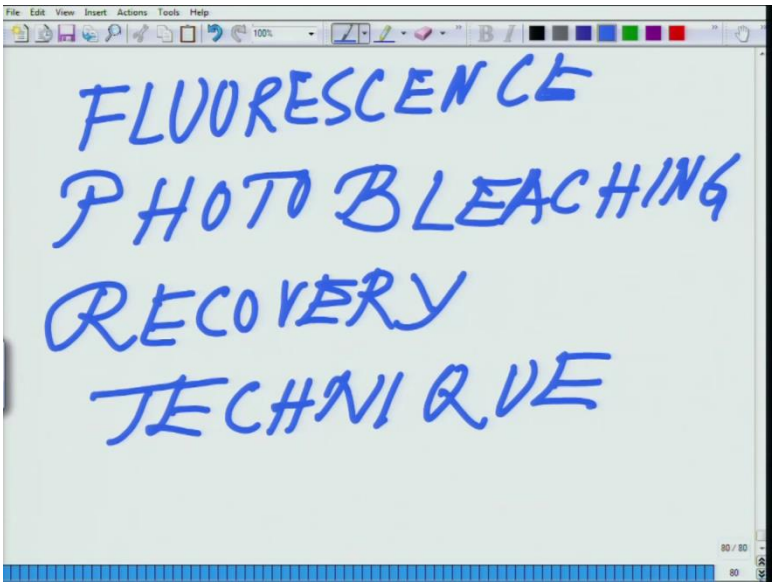

So, that is called florescence photo bleaching recovery technique; what this technique is about? This is a very interesting technique. So, this technique is like say for example, I have a cell like this.

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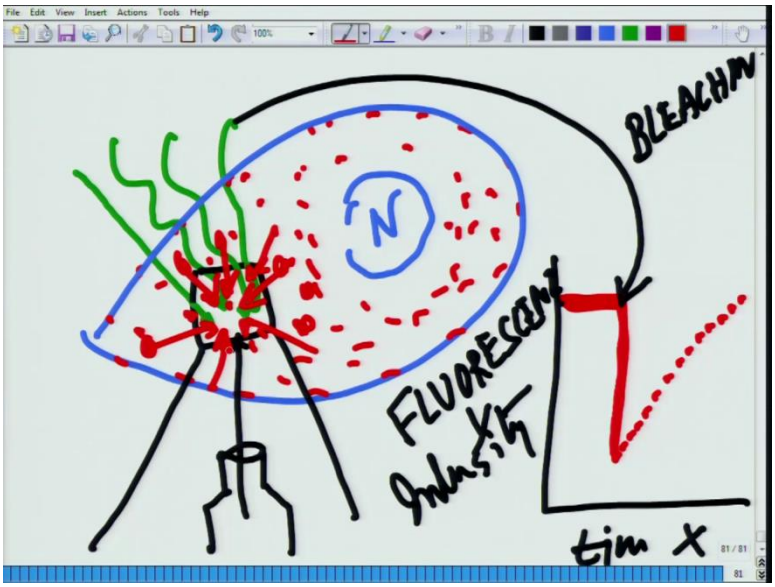

I have a cell like this fine, and in the cell this is the nucleus and all those things and this is the membrane on this cell what I do? I tagged it with some kind of a florescent probe. So, these are the fluorescent probe already these are fluorescent. So, what I do? I pick up 1 spot say for example, I pick up this spot and I put my microscope at this spot. So, there is my microscope you could see here is my microscope I am seeing this spot. So, what I do at this point? I record say for example you know, I have x axis y axis. So, I am recording fluorescent intensity on y axis fluorescent intensity on y axis and x axis is time. So, initially what I see at this spot there is a fluorescent intensity like this let me put it in red that will make more sense.

So, then what I do next thing I bring a very strong laser beam and here is a laser beam coming. Some kind of a strong beam which kind of you know bleach the whole surface or in other word bleaching the whole surface means a get rid of all the fluro force which are present out here. So, all the fluro force which are present out here. So, it is free from all the red. So, what you will see in the graph is that immediately fluorescent immediately the fluorescence intensity will fall down like this sharp fall. Because of this is where you were bringing this is where bringing the bleaching coming into place. After sometime what you see is that there is a recovery it started pulling back what exactly is happening. Why it recovered? It recovered, because all the surrounding these molecules what you see these molecules started moving to the bleached side like this.

In other word there is a mobility and the movement of that different proteins and the lipids which are present. So, these are 2 standard techniques by which it has been proved that this is the mobility of the lipids and the proteins across the membrane and very rarely you will see a flip flop movement which I explain in the last class. So, membrane proteins do not rotate across the bilayer membrane bilayer, but some time the lipids do, so very, very slowly based on all these we moved on to the. So, there are over the last century several models of the membrane has been proposed, as we are advancing as we started understanding many of the older models got discarded. And the most current model which is fairy acceptable is called fluid mosaic model. This was proposed by in 1972 by Jonathin in singer and Garth Nicolson.

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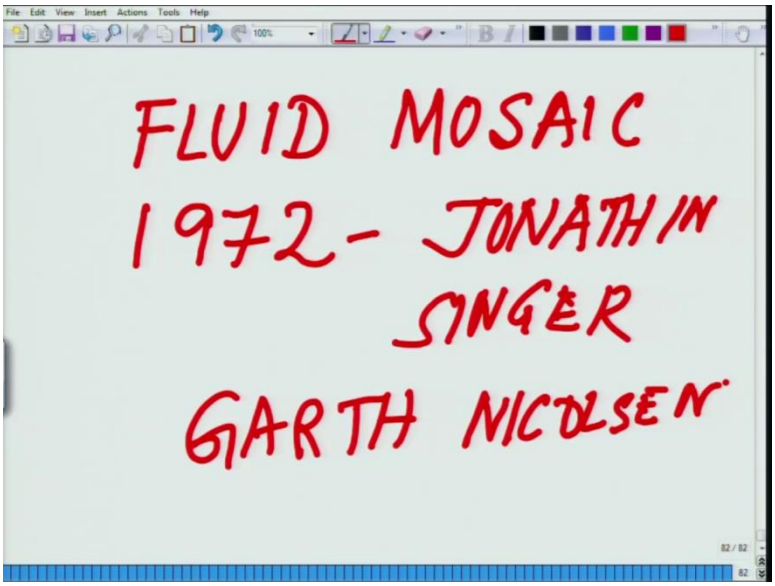

So, fluid Mosaic you understand mosaic; mosaic is like in your house you have the mosaic floor. So, it is kind of mosaic like it is a mosaic proteins in the lipids something like that, how you can 1972 by Jonathin singer and Garth Nicolson.

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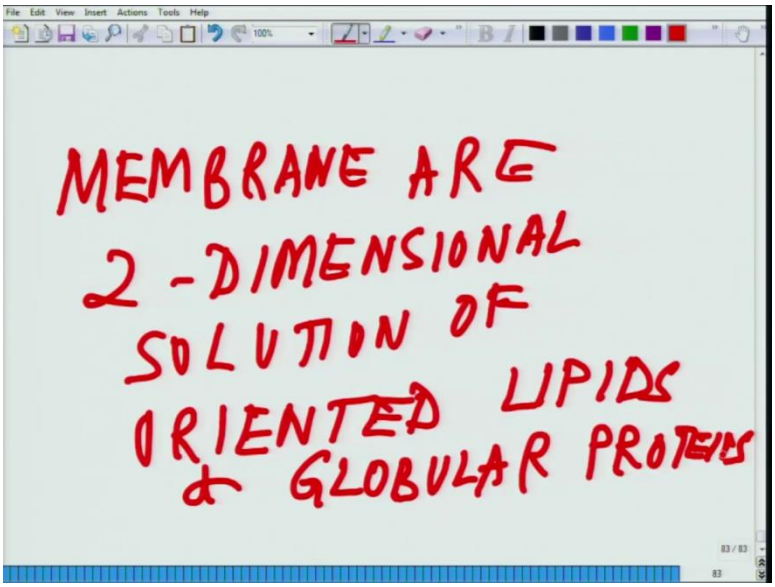

These are the 2 people who proposed that Nicolson what they proposed is that was their basic definition of on it, it is the membrane are 2 dimensional solution of oriented lipids and globular proteins. So, this is where central theme about the model and which consists of the lipids like phosphor lipids, glycol lipids which act as a solven to embed the

proteins in them and they have lateral diffusion as which we have already discussed. From here we will move on to the next topic which is the asymmetric nature of the membrane.

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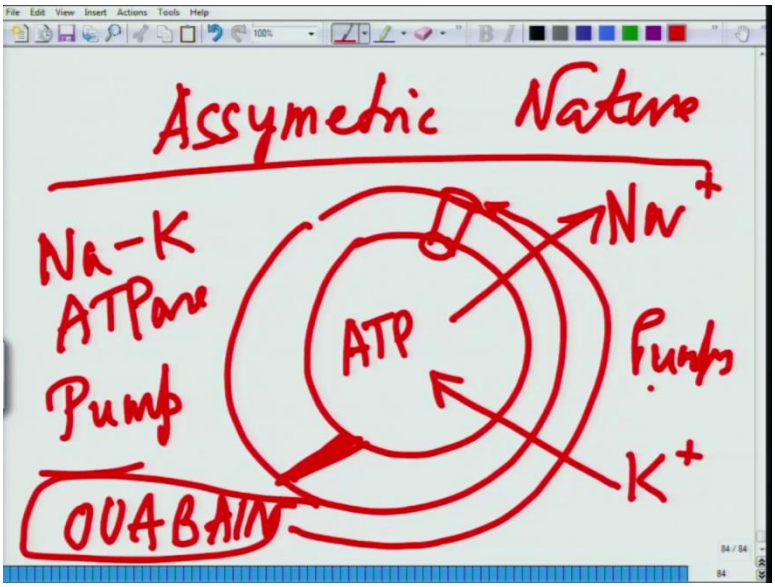

We have already discussed this, we will not discuss much on it except the fact that as I mention the proteins never flip flop and that is what helps them to maintain the asymmetric nature of the membrane. So, something like that there are some pumps like the we have not talked about 1 of the major pumps called sodium potassium A T P s pump. So, this pump has the ability to throw sodium outside the cell. And take potassium inside the cell. And this only does when ATP is present inside the cell always remember. ATP has to be present inside the cell and this is the membrane which I draw this is the membrane and this is the pump. And this offers and asymmetry this offers an asymmetry in terms of the iron concentration inside and outside the cell. So, there are certain toxins which binds from outside which (( )) is one of them which binds outside and block this block this pumps. And these pumps these channels they offer a lot of asymmetric nature to it. So, now what controls membrane fluidity?

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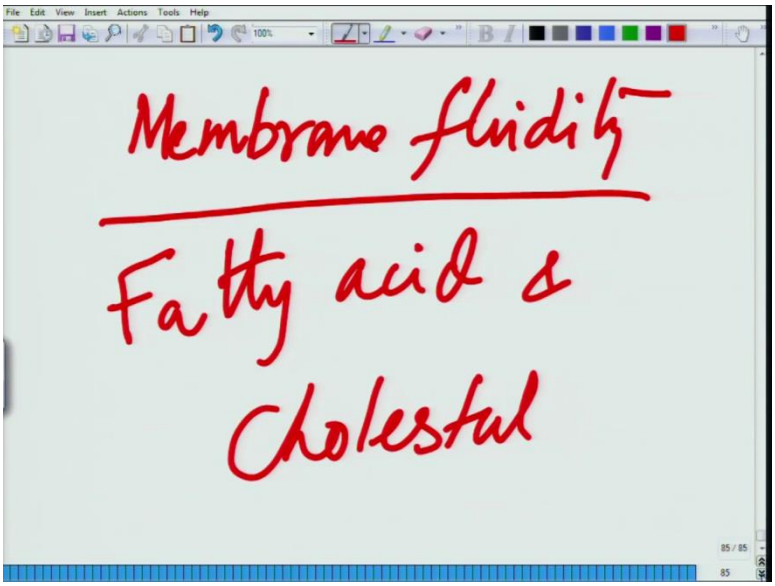

Membrane fluidity is controlled by fatty acids composition and cholesterol. How it does, so say for example, if the fatty acids.

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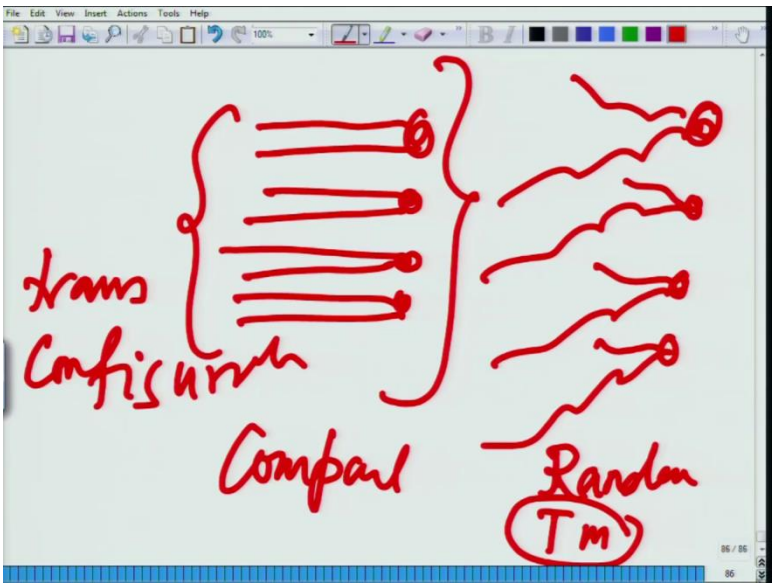

Are like this if they have all straight chain like this. The hydrophobic tail is very straight and that is only possible will when the hydrophobic tail is in is intrans configuration. So, that situation it will be a very, very compact structure whereas, think of it the hydrophobic tail is something like this, where there is a lot of sys configuration coming into place. So, this will have a this will be not very compact this is more disturbed or

much more random structure. These structures have low melting point T M which represent the melting point there will have a low melting point. So, in other words, so where as compared to very rigid structure.

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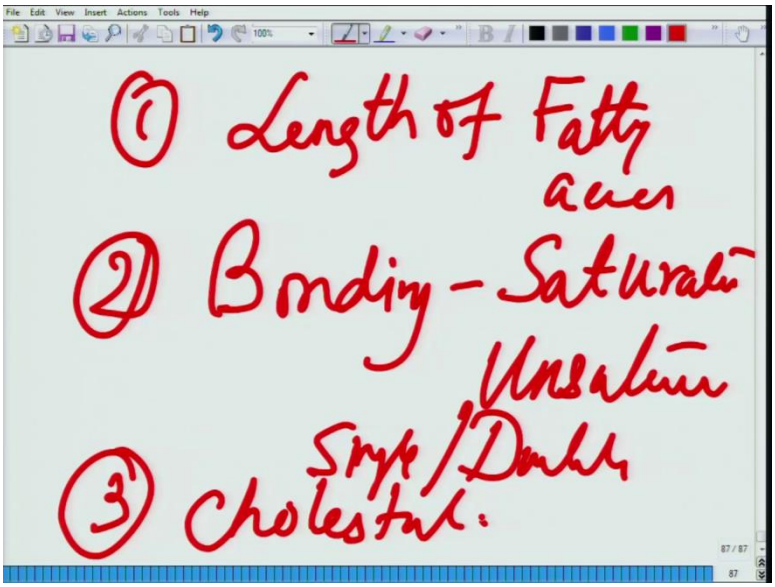

So, there are 3 parameters which decides the length of the fatty acids the kind of bonding they have saturated or unsaturated saturated or unsaturated. In other word the presence of single or double bond and on top of that the cholesterol, where we started this class. The cholesterol decides a lot about how the membrane fluidity is going to change, change the last one minute I am going to devote now about the carbohydrate.

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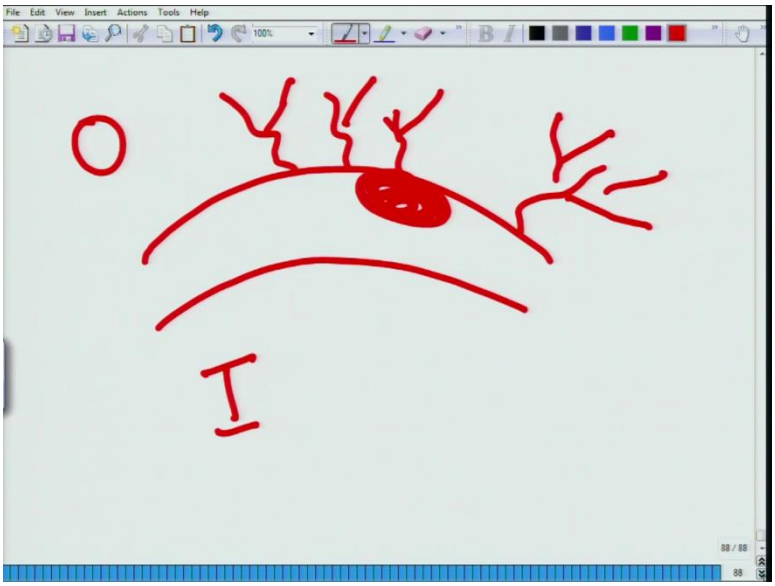

So, if this is the membrane most of the carbohydrate points on the outer side. If this is O is out and I is in the carbohydrate moiety is there outside either attached on top of proteins like this. If this red thing is the protein or directly attached to the lipids, they could be a glycol lipids or they could be a glycol proteins. And apart from it there is another technique, last technique which I just want it for your information; these membrane proteins could be isolated using several detergents like triton.

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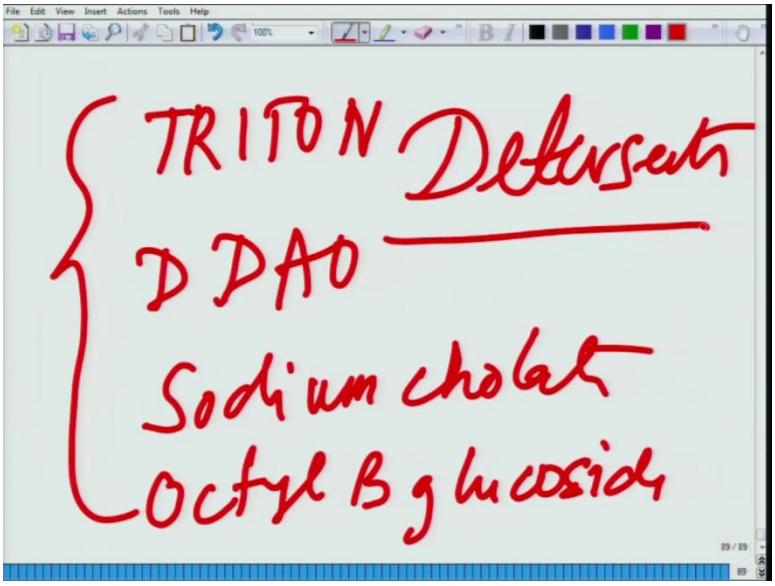

D DAO; they have several full forms that is do dimethiloxide sodiumcollate and octyl bita glucoside. These are different detergents which could be used to isolate the membrane protein. So, I believe this is what is essential for you people to understand that membrane is a very dynamic structure it is asymmetric in nature. It is extremely fluidic and all these parameters changes whenever they are some changes in the body and with this. We will move on to the, we are closing on this lecture and in the next lecture will talk about membrane of the nerve and muscle.

Thank you.