Animal Physiology

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Lecture - 3

Welcome back to the lectures in animal physiology. In first two lectures, we talked about the introduction to physiology cell animal physiology, that was our first section, we covered two lectures. Now, we are into the third lecture, as well as in the section 2. This will be the first lecture of section 2 and our section 2 is about membrane physiology of nerve and muscle.

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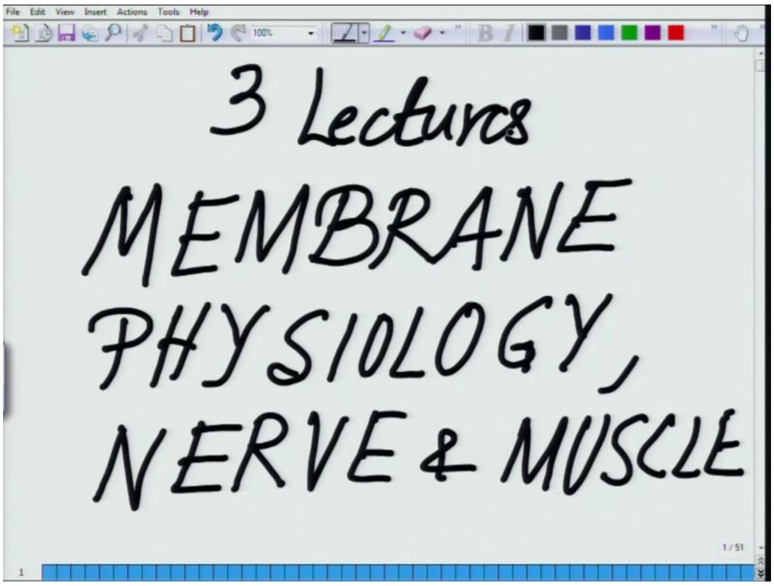

This is section 2, membrane, which is the one of the most key feature of any entity. We will be taking two examples of nerve cells and the muscle cells, and their membrane phenomenon. In this section, we will be covering two lectures, sorry, will be covering three lectures in this section. What we will do now, we will start with the first topic, which is membrane structure and dynamics.

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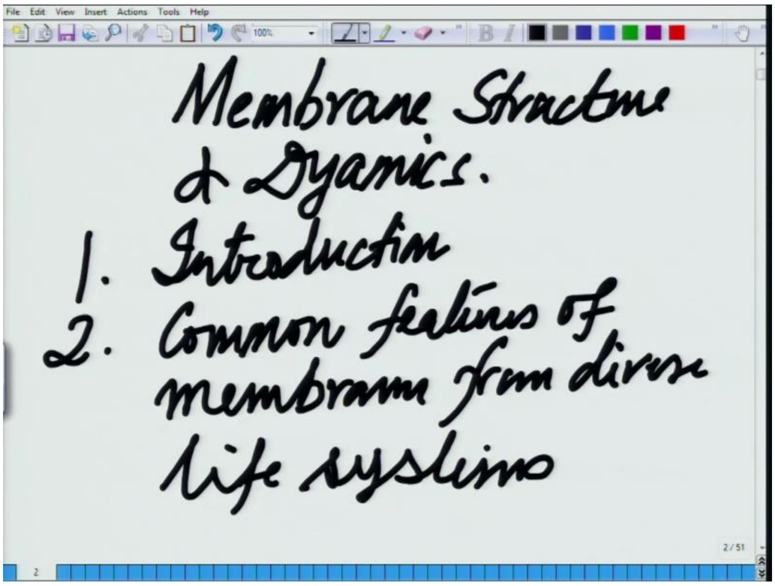

Under membrane structure and dynamics, we will be covering the introduction to the membrane; that will be our first topic, which I will be covering in this lecture. The second thing is the common characteristics or common features, among membranes of different species. Say for example, we have plants; we have animals and many things; bacteria; algae. They all have membranes. What are the common features of membrane from diverse life systems is the second topic, which we have. In the third topic, we are going to cover; the third thing we are going to cover will be the major classes of the lipids.

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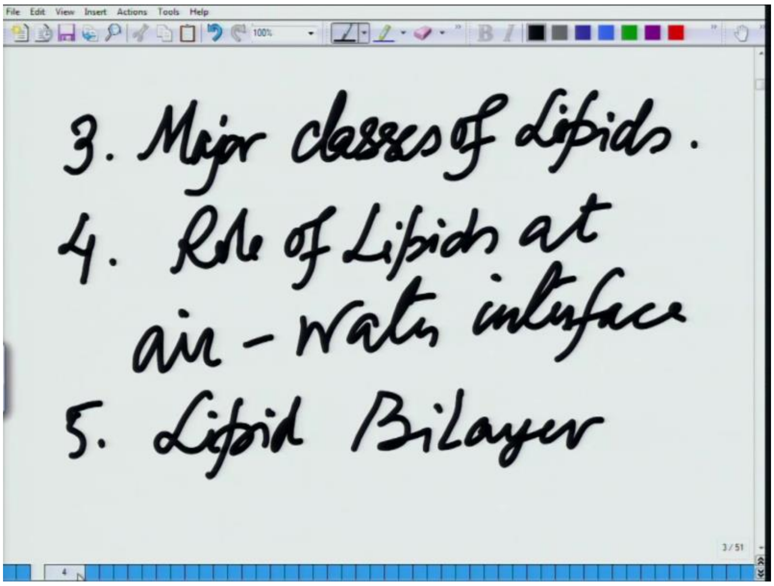

As you remember, in our first lecture, I told you the membranes are form of lipids. We will be talking about the complete classification of the lipids. Then, role of lipids at air-water interface and then we will be touching upon lipid bilayer and its significance. With this, let us move into the first topic, which is the basic introduction about the lipids. There are wide ranges of lipids all over the system. Sorry. Let us start with the basic structure of the membrane. There are wide ranges of membranes all over the system. Then, we will be talking about the basic characteristics of the membrane.

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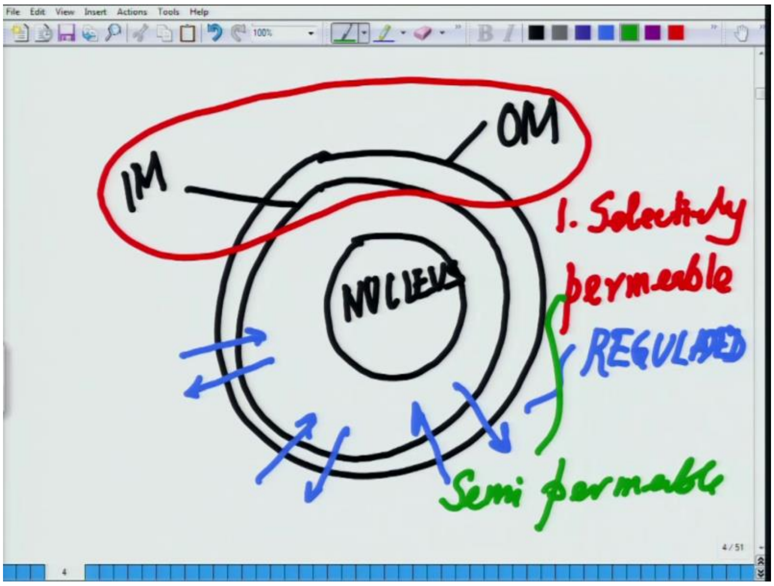

So, for example, whenever, if you remember in one of my first lectures, I drew a cell like this. This is the membrane and this is the nucleus. This is the outer membrane and what basically, it is doing, and it has another membrane which is called as inner membrane and you have the nucleus in the inside the cell. What you will be dealing is, we will be dealing with the structure of this. So, these particular kind of membranes; any membrane as a matter of fact, has some common features.

One of the first common features is that they are selectively permeable. This is the very common feature; selectively permeable. In other words, what does that mean? That means that any entry or exit of molecules, across this membrane is completely regulated. It is a regulated event. It is not, that anything go in, anything can come out of it. It has to be very well regulated. That property is called selective permeability and in some books, you will find, this is also called semi permeable membrane.

It is not permeable to everything. It is permeable to only selective entities. All the membranes are like that, because why it is very essential for us to understand? Why the membranes are semi permeable? We all believe the life has evolved from ocean. As you know, those of you have been to sea, the ocean or bays; you must know that ocean is very salty and it is exceptionally challenging for biological phenomena to happen in such salt water. So, somewhere or the other, life has to form. The first membrane has to form where, we got rid of salt. We formed an enclosed structure, which does not have that much high salt concentration.

That is why, the first membrane, which has formed and evolved, may have developed mechanisms by which, it could regulate the solute concentration inside it; especially, the salt concentration, like sodium, potassium, calcium and all these things. We will be talking about this and how the concentration of different ions, like sodium, potassium calcium, magnesium, varies from inside and outside the cell and what regulates all these things? This feature falls under the selective permeability of the cell. The second feature is that what actually, dictates the selective permeability of the cell.

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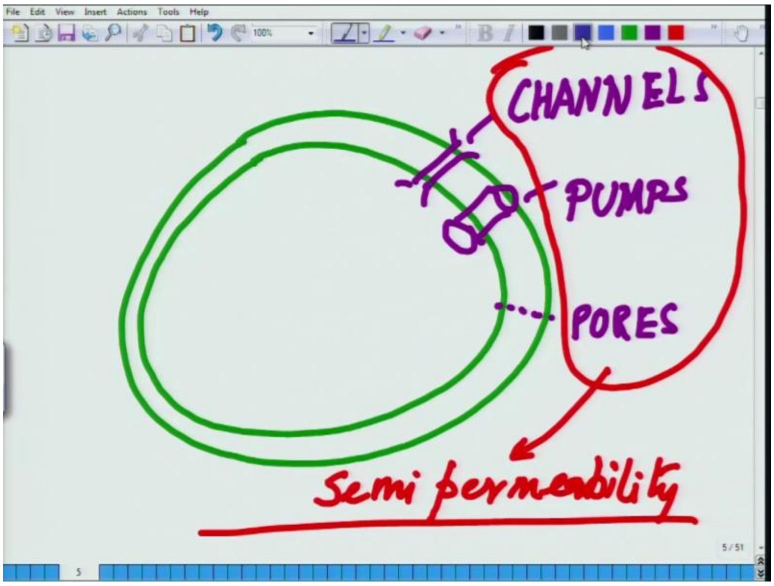

Selective permeability of the cell are governed by; if this is the membrane you see this is, say for example, this is the inner outer membrane. There are wide ranges of channels out here. There are channels, which are like gate. There are pumps, which regulates; pumps, channels and you have small pores. These are the ones; these three features and many other features decide the semi permeability of the cell. This is another common feature among the cellular structure. The third aspect is, in this stuff, say for example, think of it. Whenever, we feel heat or cold, our skin responds to it. In other words, this is the skin and this is responding to some kind of hot or cold. It means these consist of all different cells. So, these cells have different sensors on their body, on their top. In other word, if I have to draw it, it will be like this.

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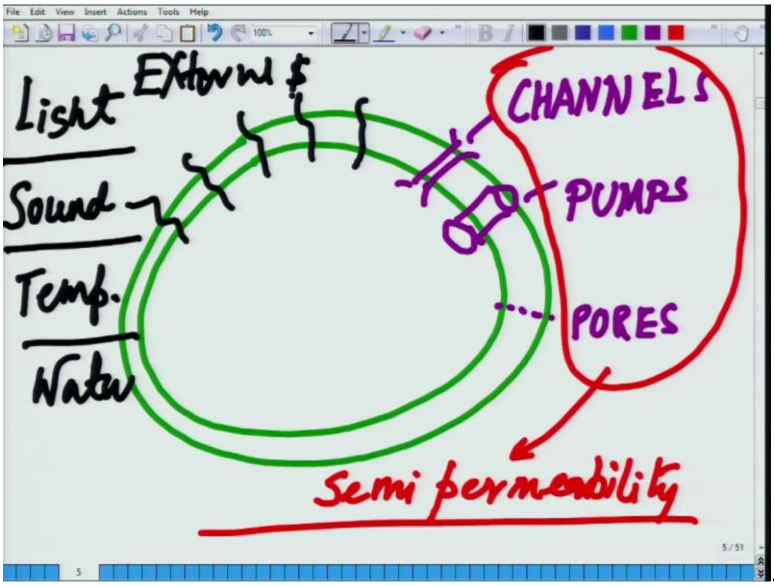

On top of this you have these kinds of say, you have sensors. These could sense several things. These could sense light. These could sense sound, vibration and will come to that. This can sense temperature. This can sense water and several other things. These features help a cell to respond to the external stimuli. These are all outside. This is another feature of the cell.

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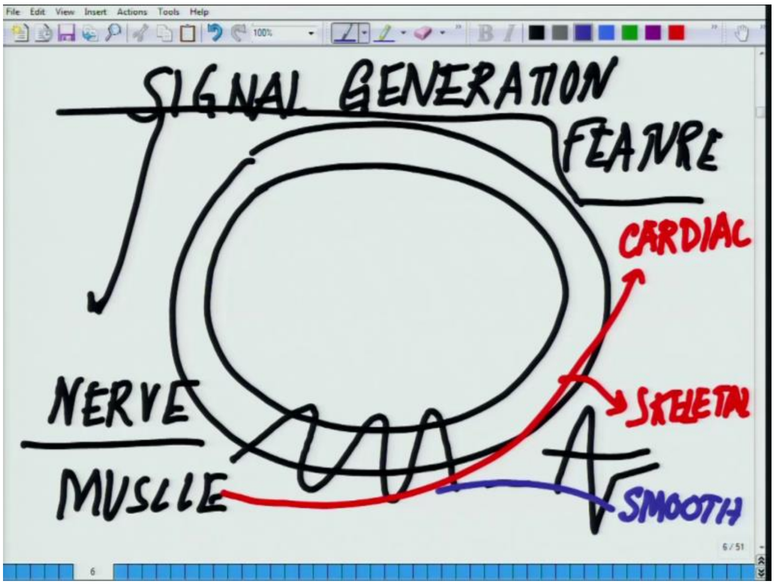

There is another feature, which is most of these cells, say for example, if I draw the cell now like this. These cells change their permeability and their ability to generate signals, which could be electrical in nature; signal generation ability. Signal generation feature: this is another common feature of the different membranes present in the cells, which includes the nerve cells. We will be talking in depth, eventually, on this and the muscle cell, which includes both kinds of muscles; the cardiac are the one, which is forming your heart, and the skeleton, which is forming most part of your body. Apart from it, there is another set of muscles which are called smooth muscles, which lines your intestinal or gastro intestinal track.

These have the potential, or these cells have the feature of generating electric signals as well as chemical signals. So, this is another feature of these kinds of membranes which are developed. There is one more feature, which is very fundamental to the very core of our existence, is the bio energetic features; that mean, there are membranes, which has the ability to trap sun light, and convert it into electricity.

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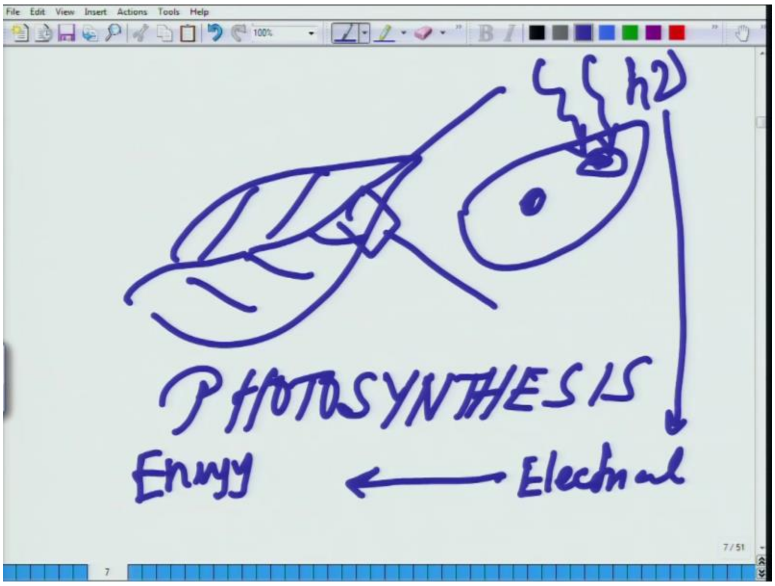

What we see in the plant kingdom, which all of you must have heard, something a word called photosynthesis. What exactly happens in that is there are some specific organelles, which are present in the cells of the plants called chloroplast. This chloroplast has the ability to absorb light in the membrane of the chloroplast. This light energy is converted into electrical energy and by virtue of which, the energy rich molecules or energy molecules are synthesized. Of course, this is an example of the plant system.

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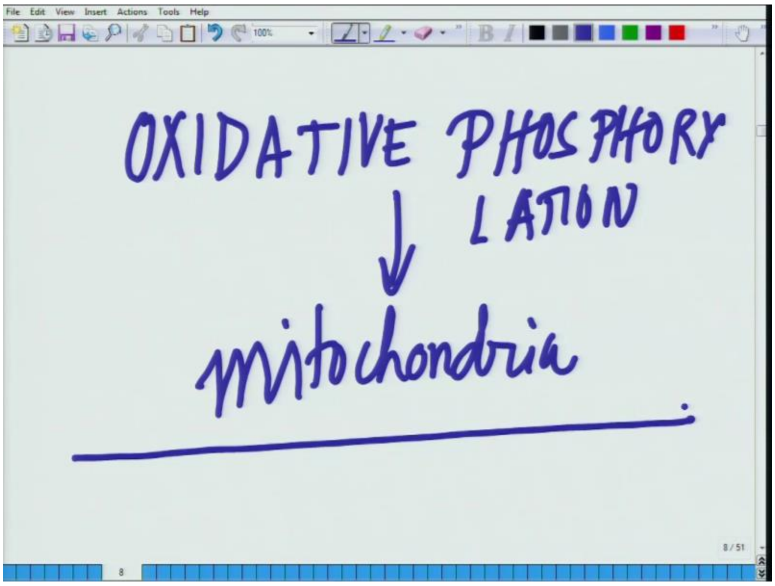

Same happens in the animal system, which we call as oxidative phosphorylation, which takes place in the mitochondria of the cell. You will be remembering as I was talking about mitochondria, in the last class and of course, we will go in depth into it. So, this is also a membrane phenomenon.

If I have to summarize, what all the common features that membranes have; introduction; its semi permeable in nature; the membranes have channels, pores and pumps in their structures; they respond to different kind of stimuli, which includes light, sound, water, volatiles, like smell; we smell through our nose, we could figure out whether this smell is bad or good, or it is a perfume or is it some other stinking smell. Then most of the membrane; there are series of membranes, which has the ability to generate chemical or electrical signal, which include nerves and muscles. Yet, there are some specialized membranes like, membranes of the cloroplast in the plant kingdom and the algal kingdom, which has the ability to convert light energy into electrical energy, as well as, there are membranes in the mitochondria of the cells, which has the ability to do oxidative phosphor relation to generate energy, and that is why in mitochondria.

This is called the energy unit of a cell, or the power station of the cell. So, with this brief introduction now, we will go on to the part 2 of this membrane structure and dynamics, that is all these membranes are found in several systems. It could be plant; It could be animal; it could be algae; it could be anything and everything. So, what are the common features? Now, we will be talking about the second thing, which are the common features of membranes among the diverse life forms, which are present on the floor of the earth.

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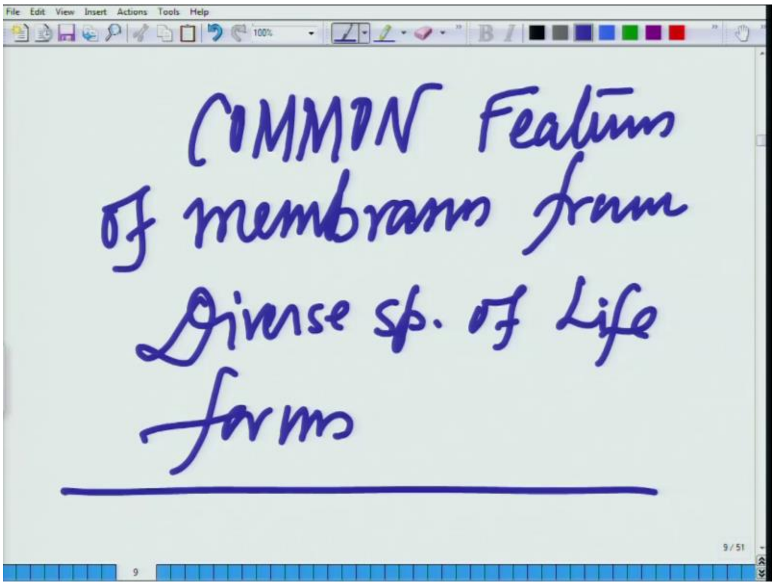

Talking about the common features now; we are moving into slightly more details. Common features of membranes from diverse species of life form- this is the aspect which we are going to deal now after once, we are done with it. The first and foremost feature; let me highlight here. Most of the membranes are made up of lipids. The major component of lipids, along with proteins, which we have talked yesterday. I promise that I will be coming back to the classification of the lipids, of their structural or the membrane lipids, in this lecture, and I will do very soon. Most of them are made up of lipids; proteins; as well as, on the top of these proteins and the lipids, there are carbohydrate molecules, which are attached to them. In other words, if I put the first common feature about them, is that membranes are made up of lipids; one of the key components, protein; another major component.

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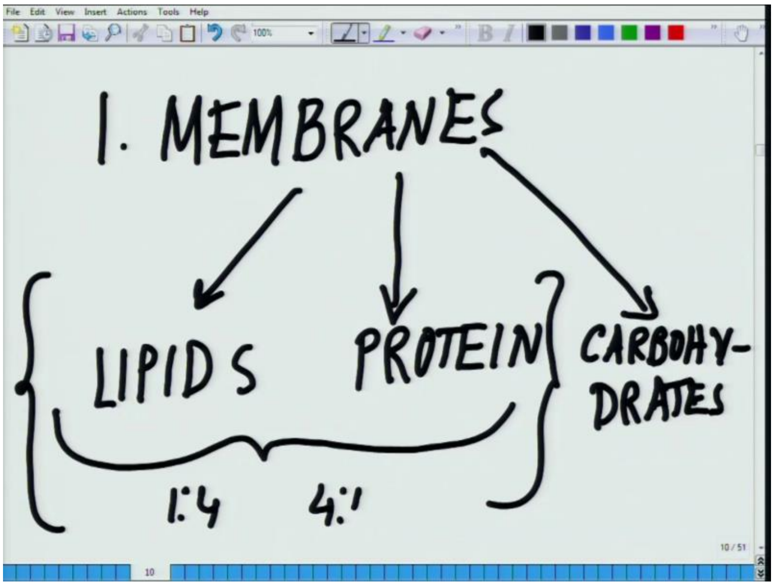

Third component is your carbohydrates. These lipids and proteins are present at specific ratio, in all the membranes. They are 1 is to 4 to 4 is to 1. This is the ratio in which these are present, and in all these lipids, the carbohydrate moieties are attached or in the proteins. When they are attached to the lipids, they are called glycol lipids. When they are attached to proteins, they are called protein carbohydrate hybrid things, which are glycol proteins. So, it could be attached to lipids; glycol lipids and if carbohydrates are attached to proteins, it is called glycol proteins. So, this is the first feature; that the membranes are made up of lipids, protein; the major component and the component of carbohydrate, which are attached or covalently linked to the lipids, as well as, to the protein molecules. This is the first feature.

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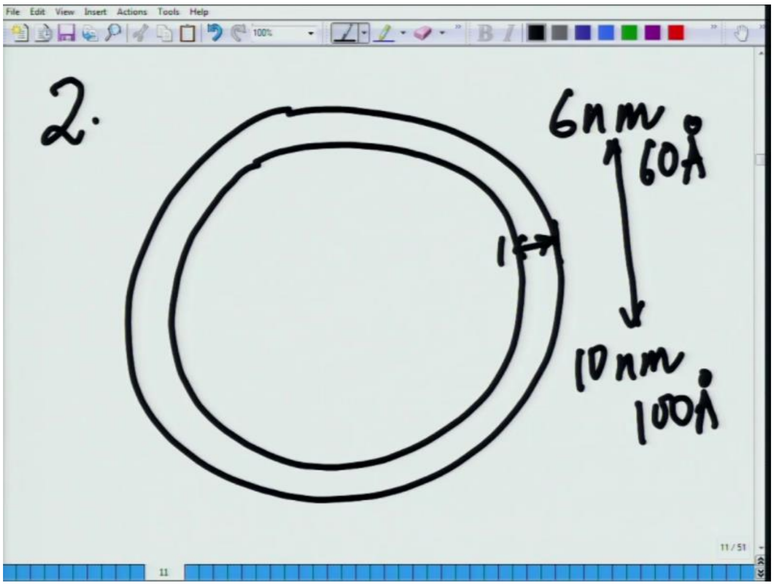

From here, we will move on to the second feature. Second feature is, while I was drawing the membrane, there is something like this. So, what is the thickness of the membrane whenever we talk about this? Most of the membrane varies from 6 nanometers to 10 nanometers, depending on the life form. In other words, it varies from 60 angstrom to 100 angstrom. This is the dimension of the membrane that we talk; most of the membranes are of that dimension

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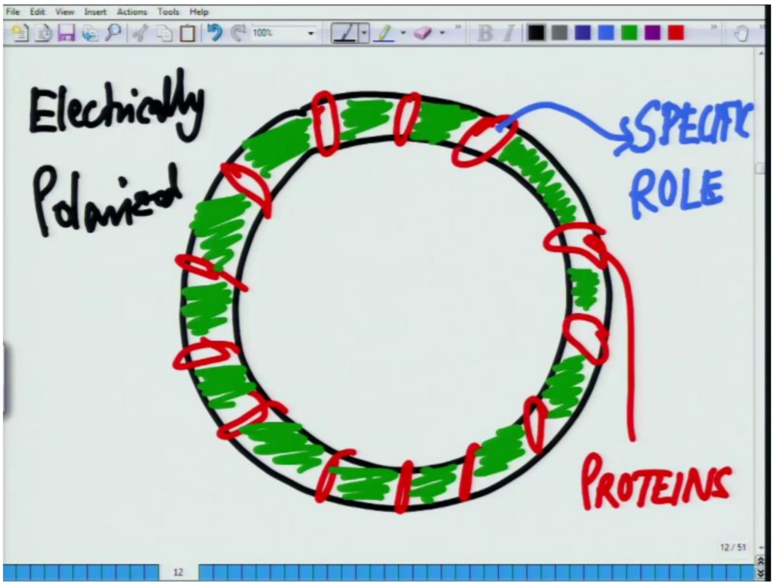

Now, talking about the membrane structure, I told you there are specific proteins all over the place. They are embedded like this and rest is all lipids. This red ones are the proteins which are embedded out there, likewise. The green shading, what I am doing now, are the lipids, and we will come to the orientation and those of the lipids. Something like this. Now, these specific proteins which are present in a red; what you see here in this picture, they have very specific functions. They could be channel. They could be pores. They could be pumps. But, they have specific functions; specific role to play and these are the proteins. Then, you have these lipids, which are present there. We will come to the dimension of the lipids. Before that, let me tell you another very interesting feature of the membrane. Most of the membranes are electrically polarized; what does that mean? This is a very interesting feature.

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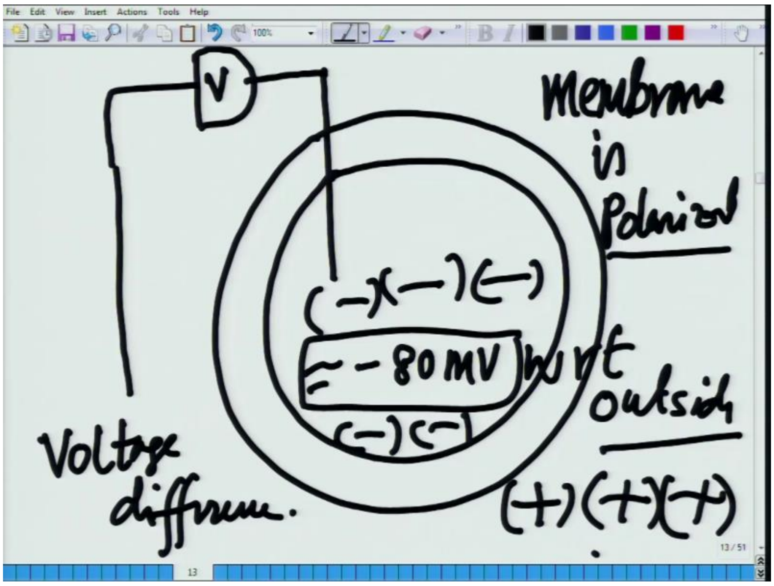

That means, if I put an, let me show you in the next slide. If this is the membrane, like this and if this is the membrane, and I have one electrode, which I am putting inside the cell, another electrode outside the cell. If I measure the voltage across it, I will find that there will be a voltage difference.

In other words, electrically, both sides are standing at different voltage, and this feature is called membrane is polarized. We will come back to this, while we will be talking about the nerve and muscle. With respect to the inside, most of the time stays at minus 80 milivolt and with respect to outside, in other words, outside is more positive as compared to inside. We will come in depth into this, as we are talking about nerves and muscle. For time being, just accept this; with respect to inside, outside is more positive.

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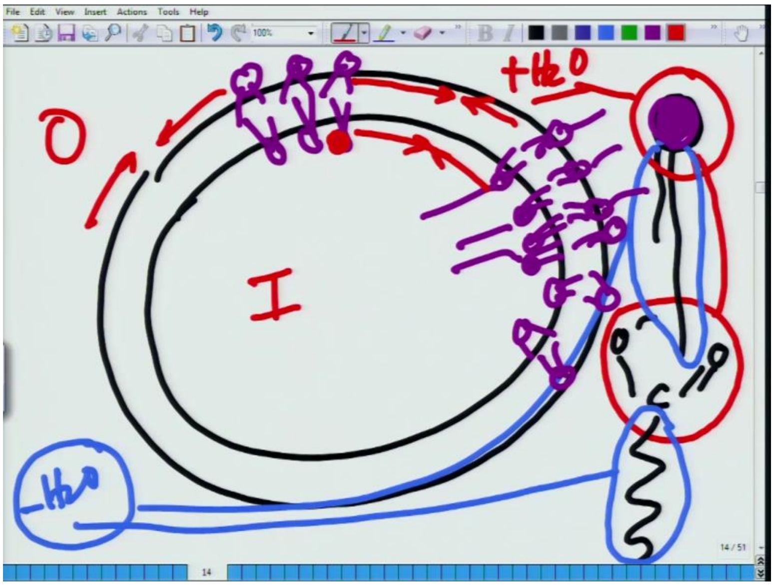

The next feature is, I talked to you about, now, I will come on to the features. This is the membrane and how the lipid molecules are oriented into it. The way the lipid molecules are oriented, in order to draw this, I have to recollect or take you back to my last lecture, where I showed you, how the lipid molecules look like. You guys remember, when I showed you this coo and o minus, and you have the hydrophobic tail. In other word, this part or the one, which I am drawing in red. This part corresponds to this part. This is the part, which I drew in red, is water loving part. This is the one which loves water. And the one, now I am shading in green, sorry, blue, this is the one; this is the water hating part or in other words, this part is the hydrophobic part, and the water loving part is the hydrophilic part.

The way the membrane is arranged, and we will come to that, how it is arranged. Just I will draw it for your understanding sake, is like this. The circle what I am drawing, you see, pointing on both sides. Basically your polar head groups; these are called polar head groups, now which I am shading. Here is the polar head group, polar head group, polar head group, polar head group, polar head group, polar head group. These polar head groups, what you see here, here, here, here, here, here, these polar head groups, kind of arranged in a very specific fashion, the way I am drawing it, you see. They are arranged like this in a way something like this.

We will come to that: why they are arranged like this and what are the reasons? Why they form that particular geometry? We will come back to this, but what I wanted to highlight here is this. In this membrane, these polar head groups; these lipids can move like this along the membrane, likewise. These ones, which are facing inside; this is inside and this is outside; the one which are facing outside, they could move like this. Whereas, the one which is facing inside, could move like this. But, what cannot happen is, that the one, which is facing inside, cannot flip outside. There cannot be a flip-flop movement. Let me draw it for you, which will make sense.

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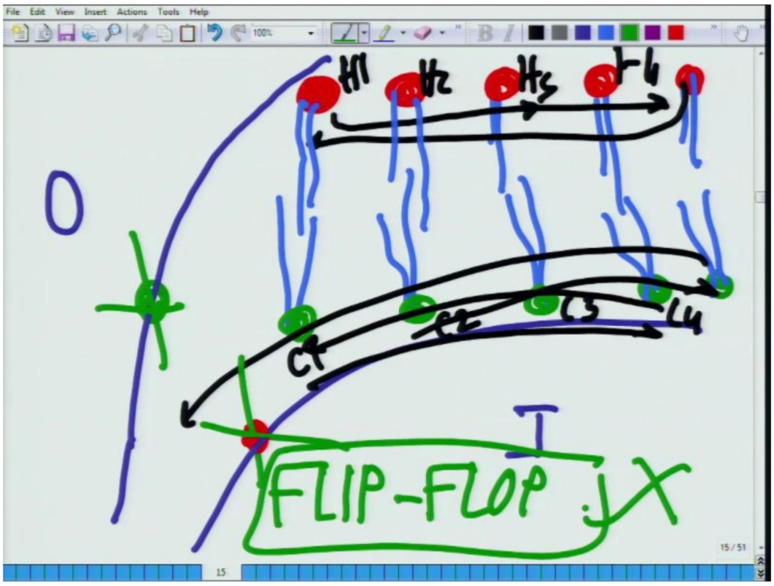
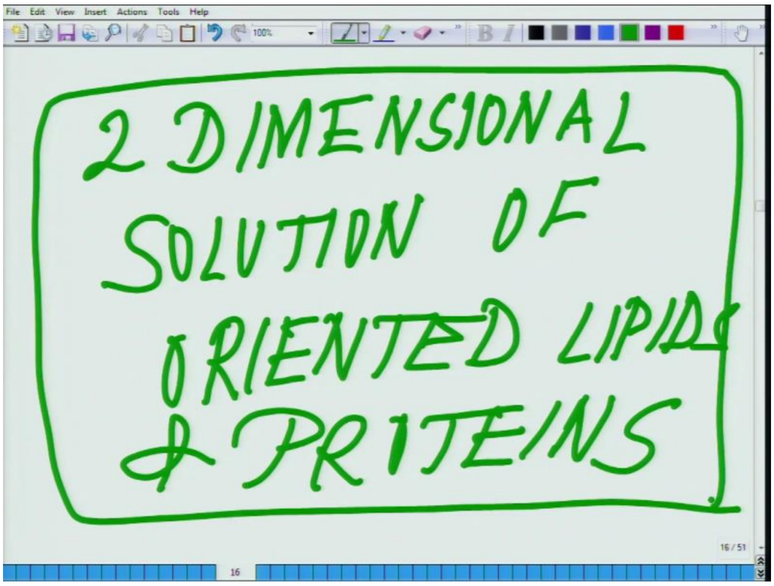


For example, this is the part of the membrane, I am doing. This is, the red ones are facing outside and say for example, the green ones are facing inside. And, these are the hydrophobic tail, what they are having, likewise and as we mentioned. This is say, outside the cell; this part is outside the cell; outside and this is inside the cell. This is just part of the membrane I have drawn. Now, let me give them some numbers. So, these polar head group numbers are C1, C2, C3, C4 and I name this as H1, H2, H3, and H4.

Now, be careful. H1 can move where H5 is or H4 is. Say, H4 can move here. There will be lateral movement like this. They could move like this, but same way C1 can move here. C4 can come here; C2 can go there, likewise. They could move like this, but what they cannot do is that it is very rare situation, where you see, a red facing inside and a green facing outside. This is really tough and this kind of movement is flip-flop. This is called a flip-flop, is a very rare phenomenon. It does not really happen; it is really tough.



But, there will be a lateral movement and because of this lateral movement, sometimes a membrane is also called a 2-dimensional solution of oriented lipids and proteins, because they could move only in the 2-dimension, laterally. This is a very interesting feature about the membranes. These are some of the common features of the membranes. There is one more, which is very interesting for you guys to realize is here.

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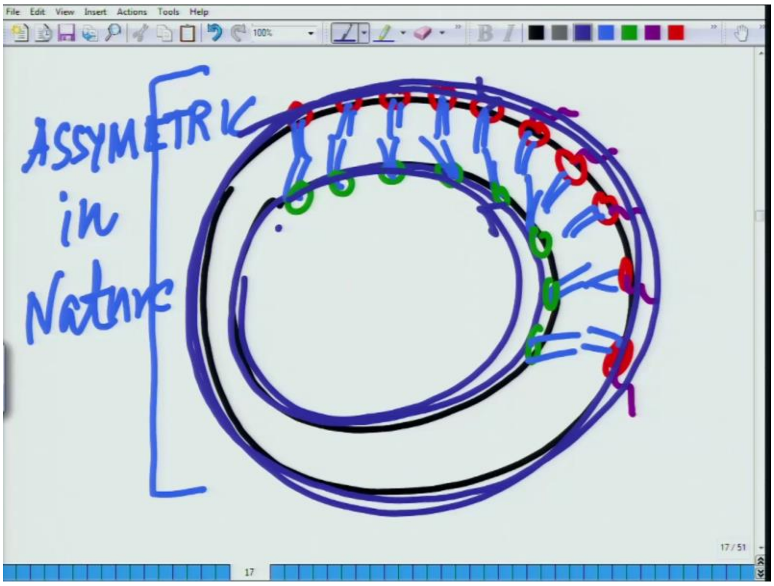

Again, let me draw the membrane to tell you. Let me draw it like this, showing all the head groups in red outside, and showing the hydrophobic tail like this. Another interesting feature about this kind of thing is that, this is asymmetric in nature. What does that mean? This means, the chemical feature of this, if there is some kind of, say for example, carbohydrate modification or some kind of other molecule modification, the properties of this surface; the inside surface is entirely different from the properties of the outside surface, because of the modification on their chemical moieties. This feature is called asymmetric nature of the membrane. This is very critical. The properties here are different from the properties outside.

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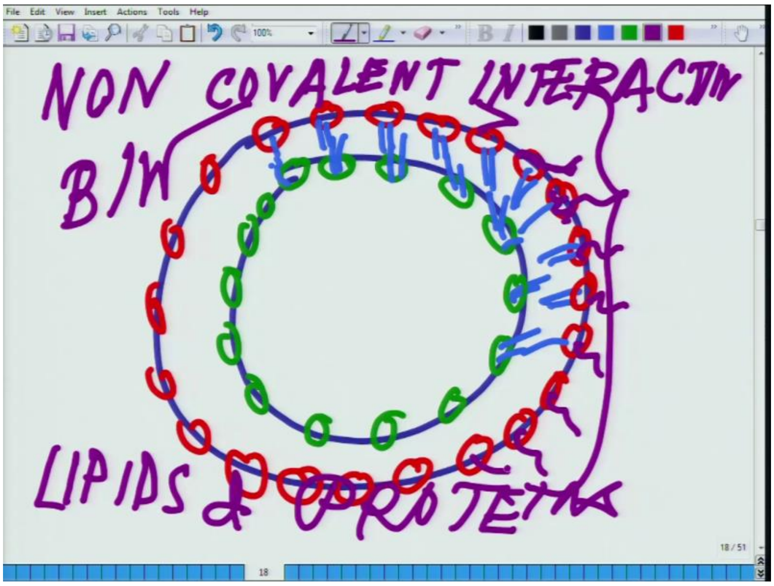

There is one more feature, which is very critical in this structure. If I again redraw the membrane and, if these are the polar head groups outside. These are the polar head groups of lipids inside, likewise. Then here you have, just for the simplicity sake I am not drawing the full thing. What is very important here is that, these lipids and proteins, which are attached, say for example, there are different kinds of proteins. Let me use another color, which will make it really easy, like the proteins are attached, likewise. All these arrangements are basically, a non covalent interaction between lipids and proteins. This is very important; non covalent interaction between lipids and proteins. If I have to summarize, what are all the features we talked about, we talked about the asymmetric nature of the membrane. We talked about the fluid structure; you could see the lateral shift among the lipid moieties.

But, rarely or most unlikely, you will see a flip-flop movement. We talked about the electrically polarized nature of the membrane. We talked about the different proteins which are present; they offer different kind of features, which you could see here. Apart from that, we talked about the ratio of lipids and proteins, is 1 is to 4 to 4 is to 1. We talked about the thickness of the membrane, which is approximately 6 nanometers to 10 nanometers, or another 60 angstroms to 100 angstroms in nature. All these lipids are amphiphathic in nature.

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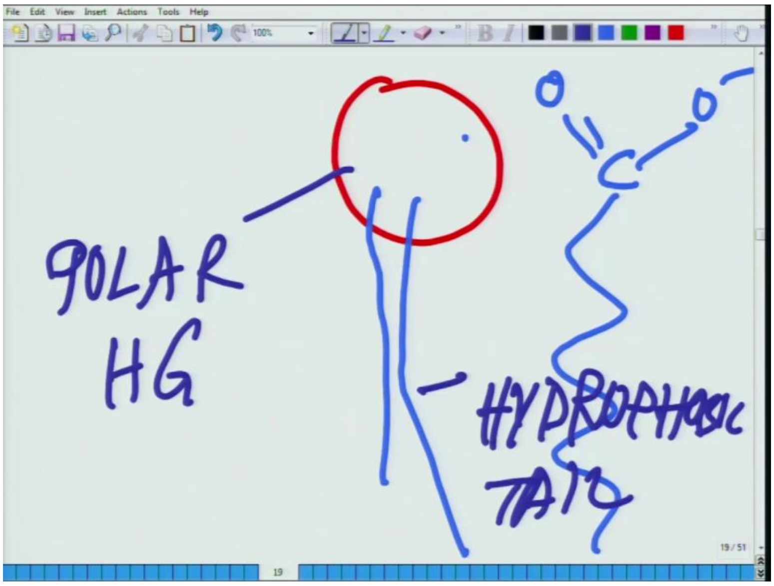

In other words, most of these lipids have something like this; they have a polar head group, which is water loving and they have a hydrophobic tail. Let me choose another color that will make more sense. If this is the polar head group sitting there. These are the hydrophobic tail. These are the ones, where you see the carboxyl group sitting there and you have the hydrophobic tail out there. This is called the polar head group and this is the hydrophobic tail.

So, these are the common features of different membranes, what we talked about. From here, I will move on to part 3 of membrane structure and dynamics, that constitute the classification of membrane lipids. In the last class, we talked about the lipids. We introduced the lipids and I told you, there are two kinds of lipids; the storage lipids and the membrane lipids. I promise that membrane lipid needs a very separate treatment because; it is a very broad class of lipids and what I will do now, we classify them. So, that you people understand exactly where, which kind of lipids are being used. We will go for a generic classification; from there we will go for the specific lipids, which are present in the membrane.

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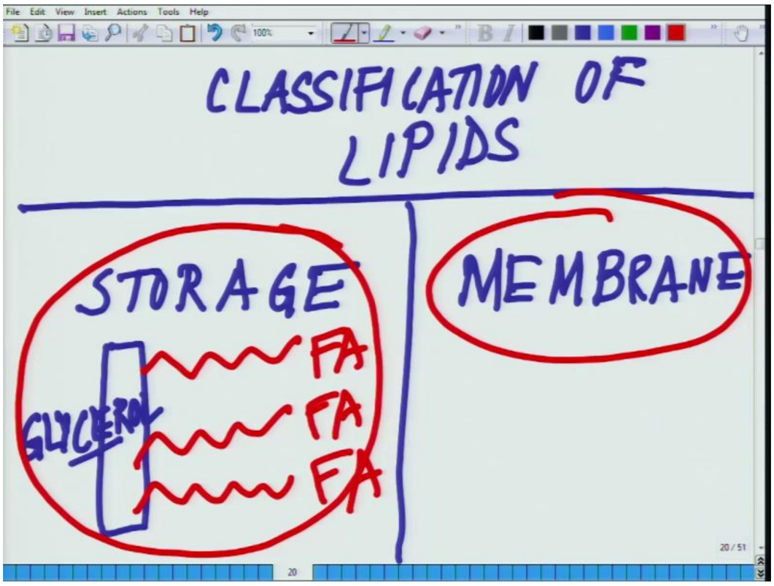

Our next topic, we will move into classification of lipids. We started the classification yesterday, in the last class. The broad classifications of lipids are storage lipids and membrane lipids. These are the broadest of the broadest classification. Among the storage lipids in the last class, we talked about a glycerol moiety, those of you remember it. On glycerol, I told you, there are fatty acids which are attached to it. FA stands for fatty acids. These are the basic storage lipids what we have already discussed. Today, we will start with the membrane lipids and all the classification of the membrane lipids. So, let us get into the classification of the membrane lipids.

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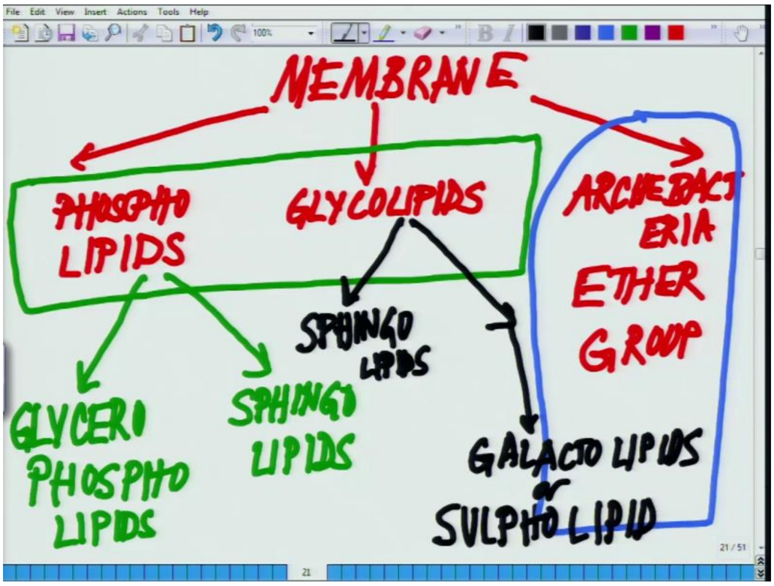

Membrane lipids could be broadly classified into three groups; one is called phosphor lipids, a very moiety. Here, phospho means, there is a phosphate group out there. One second. Let me get the spellings right. Phospho lipids, then we have glycol lipids. Then we have some very special kind of lipids, which are only found in arche bacteria. We are not going to talk about this. Just for your knowledge, I am just putting it arche bacteria. They are not found in very many organisms and these are called as ether lipids; they have ether groups in that.

This is the group, which, we are not really going to talk in this course because, this is not really our major interest. Our interest lies with these two groups; bicolipids and phosphor lipids. Because, these are the lipids, which constitute a big or major chunk of the lipids. The phospho lipids can be further classified into two groups; they are called glycero phospho lipids, this is one classification. The other one is sphingo lipids. We will come to that on what does that mean, sphingo lipids. Similarly, the glyco lipids are classified into two groups; one is called, the same name, sphingo lipids; and the other is called galacto lipids or sulpho lipids. I will write here galacto lipids or sulpho lipids. This is another class.

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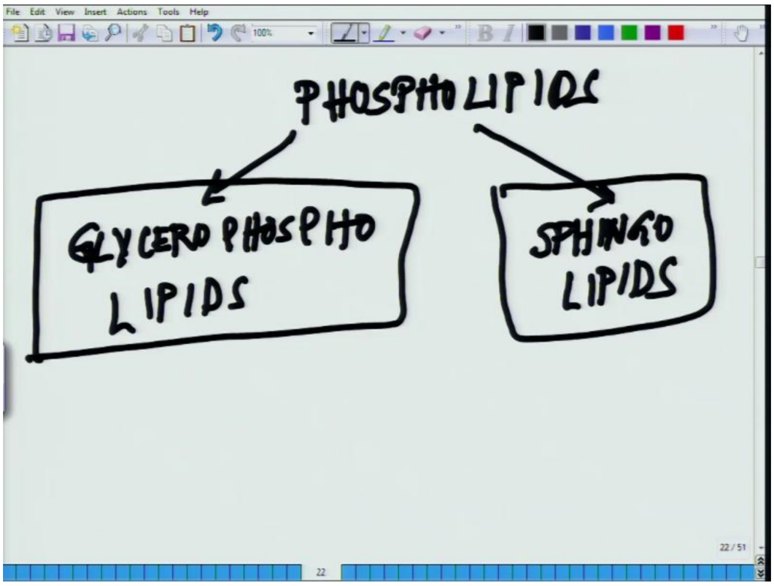

Now, what we will do, we will talk about first, phospho lipids. Within phospho lipids, we will talk about the two phospho lipids, which include sphingo lipids and glycero phospho lipids. Whenever, you go through the book you will find these structures to be very complex, but they are actually not very complex. They are very straight forward structure. Glycero phospho lipid is very similar to the original lipids.

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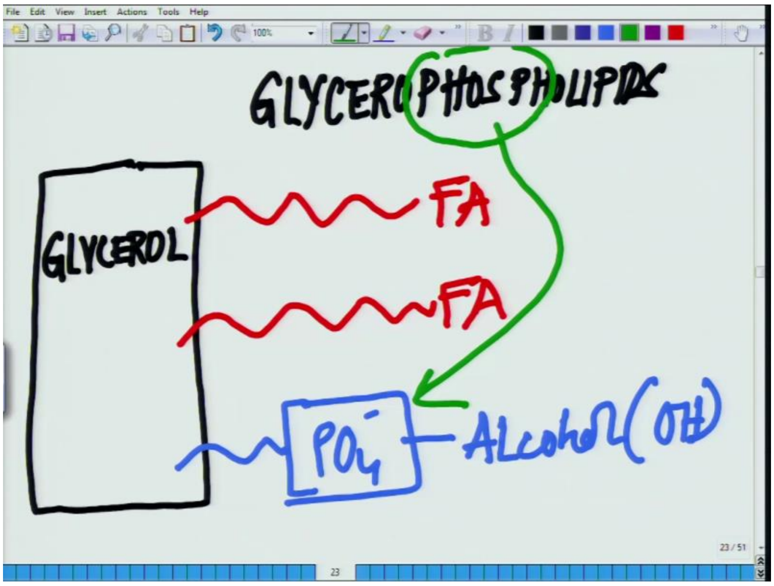

Let us talk about glycero phospho lipids and how they look like. Glycero phospho lipids look like this. You have glycerol moiety out here, which I was drawing yesterday, and you can go back to my previous lecture.

You will see the structure of it, glycerol, in which you have its fatty acid attached. There is second fatty acid to which it is attached. Then, you have some modification. You have this bond and you have PO4 or a phosphate group sitting there, and attached to the phosphate group, is an alcohol or OH group sitting there. These are called glycero phospho lipids and this phospho is coming from glycero. Let us take the phospho. So, here is that phosphor group; glycerol phosphor lipids. Next, we will talk about the sphingo lipids in that class.

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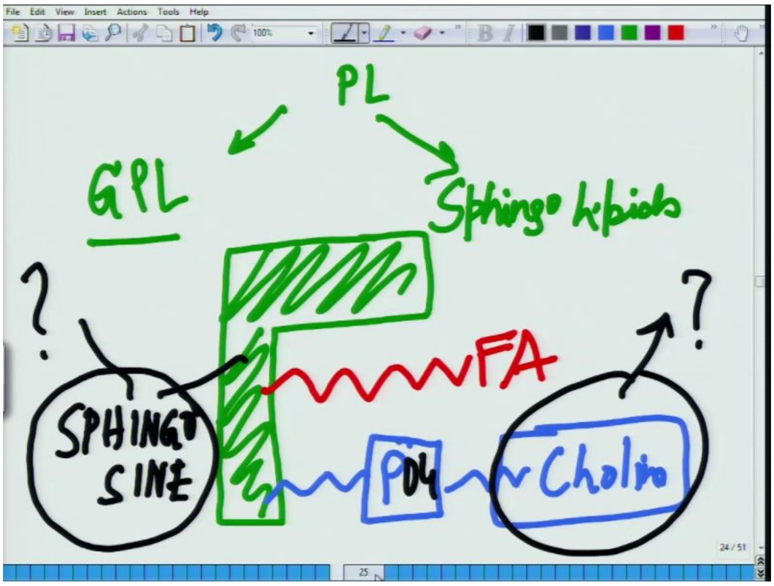

under the class of phospho lipids, we talked about glycerol phospho lipids, GPL. Now, we will talk about sphingo lipids. What are these sphingo lipids? Sphingo lipids have a very similar structure. I will draw the structure of sphingo cell moiety that will be good to understand. This is a sphingo moiety which I have drawn now. I will draw the chemical, exactly chemical nature of it and how that looks like. On that you have a fatty acid attached here, and underneath it, you have this phosphate group sitting there, and it is attached to a cholin. What is so there two new things I have introduced now, which I have to highlight. One is what is this group? This group is called sphingo sine group. I introduce another thing, which is called a cholin group. Phosphate, of course I have linked here. What is this cholin group and what is this sphingo sine group, which constitute this. What I will do now is I will draw the sphingo sine group and cholin group for you people.

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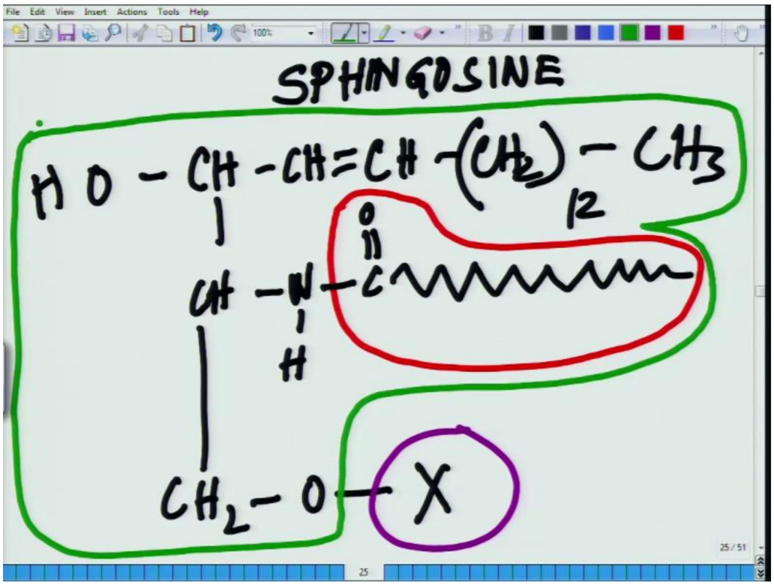

Now, let me draw what is this sphingo sine group. This is like CH-CH double bonded with CH-CH2. You have 12 molecules of it and then you have this thing and on this idea of the OH alcohol group. CH NH, C double bonded with O, and you have the whole fatty acid attached. So, this is the part of the fatty acids. Then, you have underneath it, you come back here this is the CH2, O and then you have this X, which could be anything and everything. We will come back to it. This sphingo sine is basically, this is the basic structure of sphingo sine. So, if you look at it, this is how it looks like; this and this.

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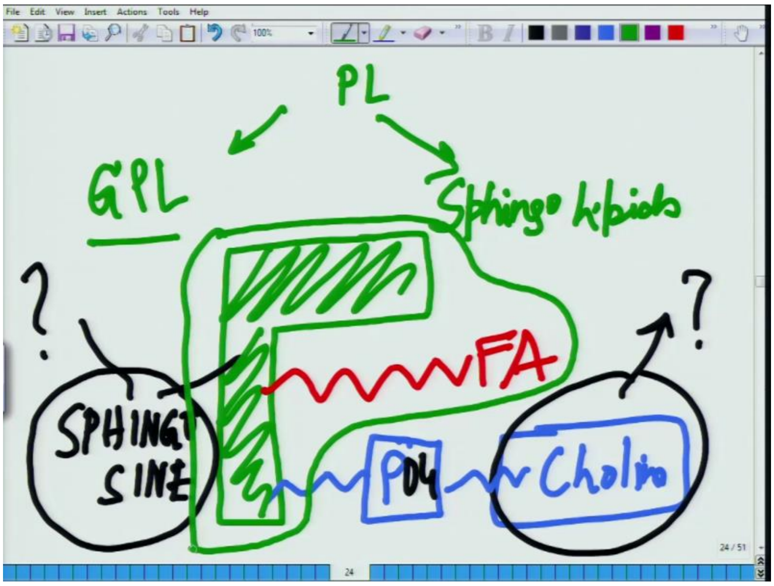

If we go back into the structure, if you look at it, it is very similar structure. If you look at it from here to here, and look at it. This is the sphingo sine moiety, along with the fatty acid come back. Now, what is this X and where I was telling you where this X matters? This X was attached to the phosphorus and there is a cholin group.

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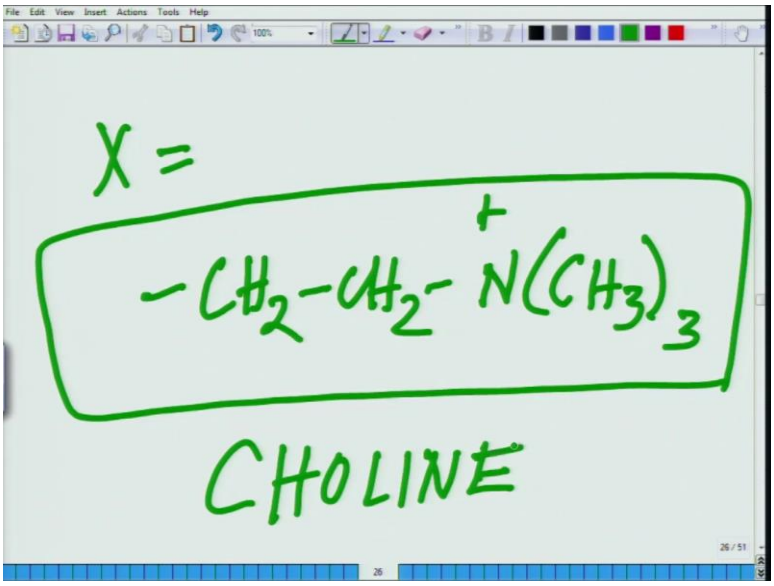

Now, I will draw the cholin group. How the cholin group looks like? That choline group is equal to will be CH2 CH2 plus CH3. So, this is the cholin group.

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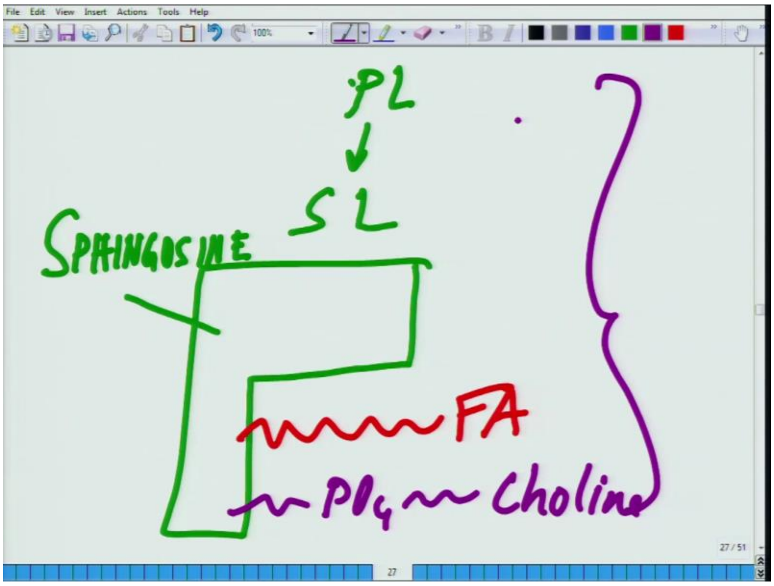

Now, if you go back to the structure of sphingo lipids; under phospho lipids you have sphingo lipids. Within this sphingo lipids we have, this is this sphingo sine moiety. Here is this sphingo sine moiety. Here, you have the fatty acid moiety and then you have the PO4 moiety and attached to it, there is a choilin moiety. This is the structure of sphingo lipids; the generic structure of sphingo lipids and there are many other modification into it.

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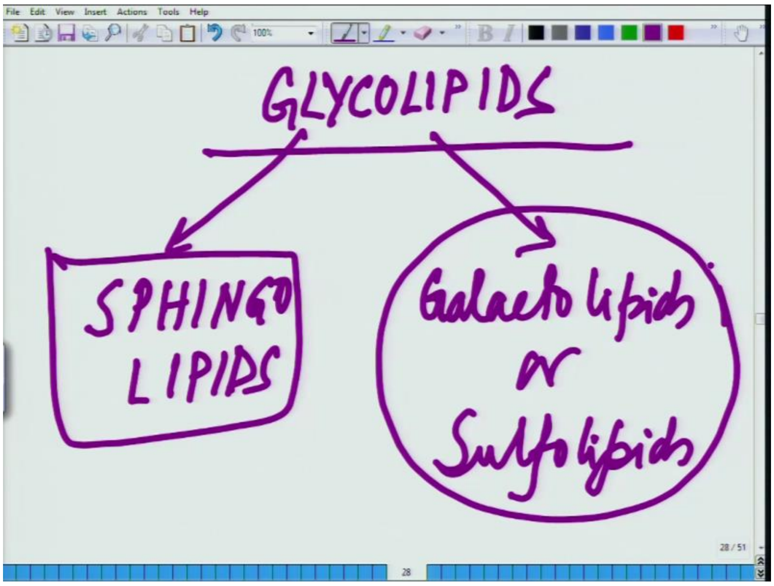

From her, will move on to the second class. The broad heading, there is a second class called glycolipids. I told you there are two classes. One is the phospho lipids; another one is a glycolipids. Within the glycolipids, again two classifications, we talked about. One is the sphingo lipids, the very moment you hear this term is sphingo lipids, you can pretty much blindly, accept that there will be an sphiengo moiety; sphingo sine moiety. Then, you have this galacto lipids or sulpho lipids, the broad heading of it.

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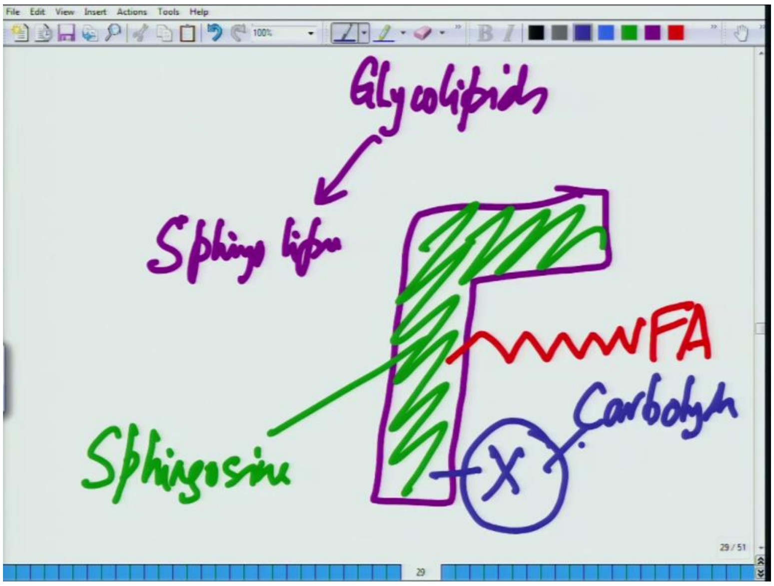

Now, what we will do, we will draw the sphingo lipids under the glycol lipids. Let us do not lose track. I am repeatedly writing it; this sphingo lipids and on top of it, you have glyco lipids within that, it is sphingo lipids. What you can do, you can draw a sphingo sine moiety likewise, then you can attach the fatty acid group. This is the sphingo sine moiety which I am shading in green now. It is sphingi sine and on top of this, you have the X here and this X is replaced by a carbohydrate. It could be a mono saccharide. It could be oligosaccharide or disaccharide.

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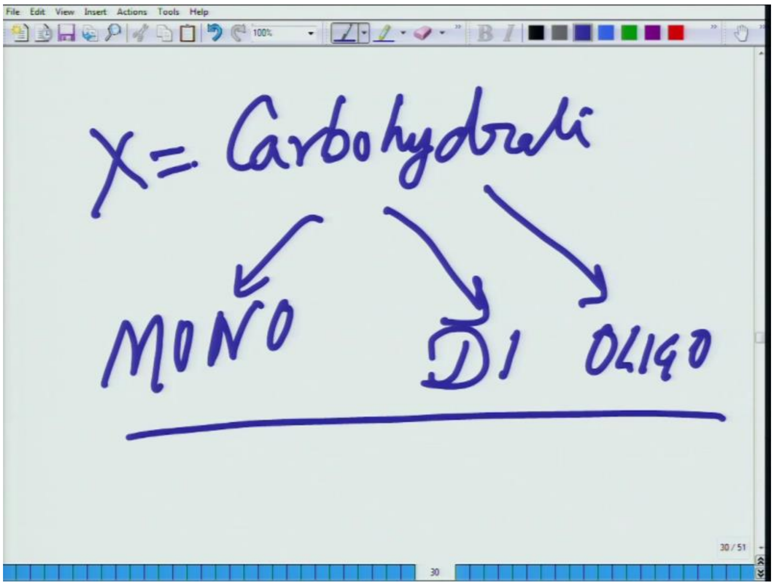

This carbohydrate could be a mono, remember in previous class, we talked about monosaccharide, disaccharide or oligosaccharide. Likewise, it could be anything that X is equal to. These are called sphingo lipids under the category of glycolipids

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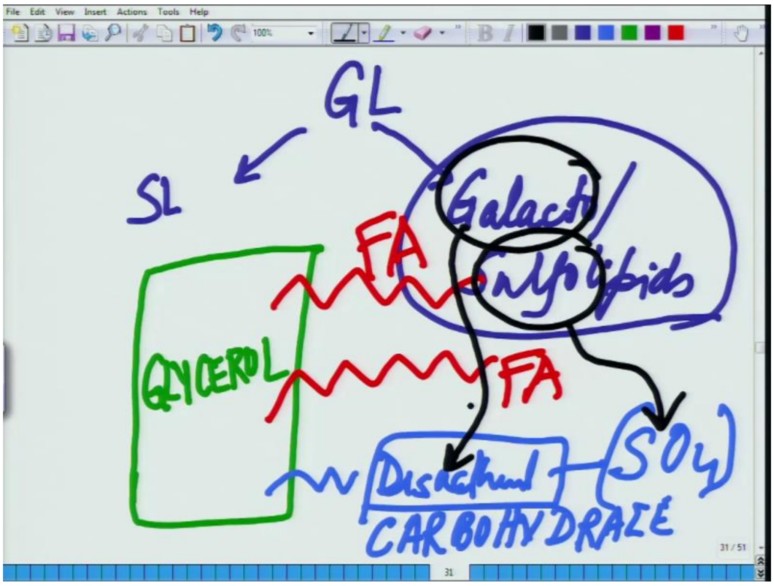

Apart from it, there is another class within that; within the glycolipids. Glycolipids stand for GL and within that, we talked about the sphingo lipids. Now, we will be talking about another one, which is called galacto or sulpho lipids. How these look like; galacto or sulpho lipids? This is how it looks like. Again, we have sphingo sine moiety, sorry, you do not have sphingo sine moiety here. You have glycerol moiety. You have a glycerol out here. You have fatty acid attached here. You have another fatty acid attached here; FA and FA. You have two fatty acids attached here. Then, there is a modification here. You have disaccharide or oligosaccharide attached here. Disaccharide or let me put it. It is carbohydrate here and to that, you have a sulphate moiety, SO4 attached here. So, these falls under, because of this sulpho, here is the sulpho group, here is the galacto group or mostly the disaccharide because, the galactose, which is a disaccharide. So, you have the disaccharide here.

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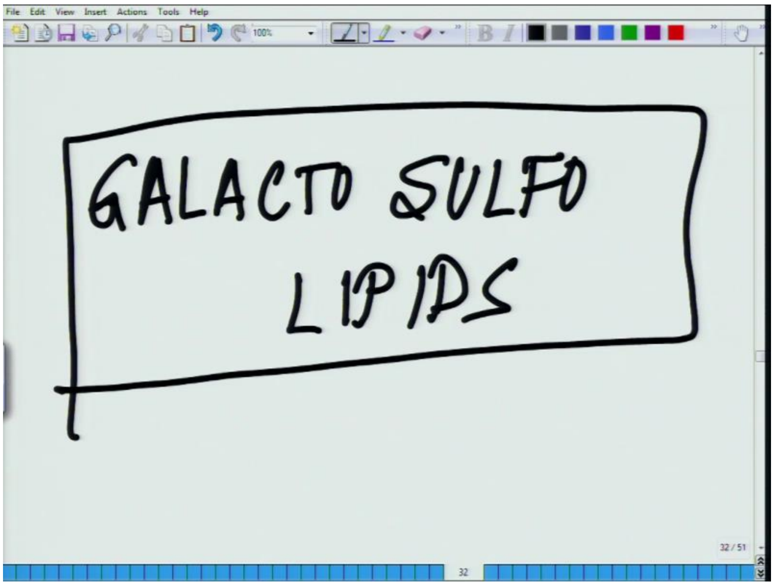

That is why it has got the name, galacto sulpho lipid. In other words, you see the galacto sulpho lipids. This is the broad classification of lipids, which is exceptionally essential for you people to understand. Whenever, we talk about membranes, you have to have fairly good idea about the different lipids, which actually, constitute the membrane. The membrane constitute of the two broad classes of lipids, what we talked about; the phospho lipids and the glycolipids. These are the two major classes and they have some very interesting features, which play a key role in the whole evolutionary process and what we are today. Now, what we will do, will talk about couple of very simple experiments, which had been done to figure out, what exactly is the structure of these membranes in terms of self assembling. Why I was drawing, if you remember, I was repeatedly drawing something like this.

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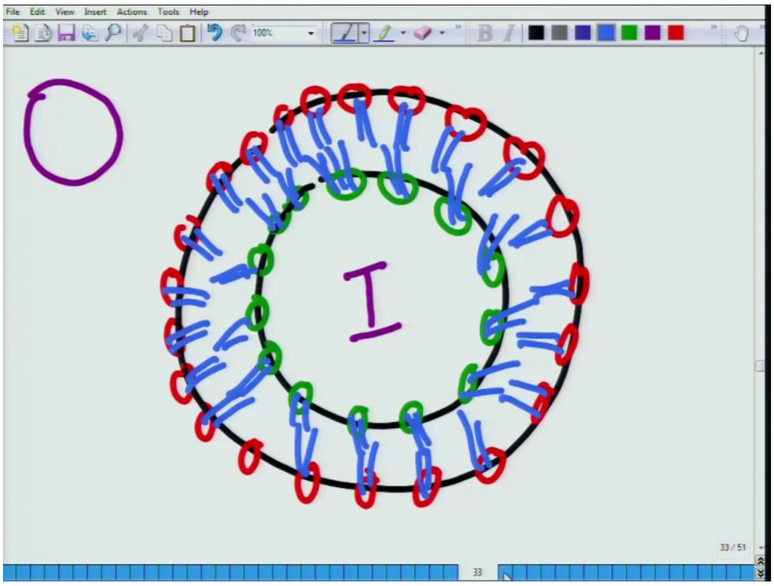

Whenever, I have drawn the membrane, I drew it like this. And I told you that I will answer this question, once we finish this lipid classification, something like this. These are the polar head groups, which I showed. These are the polar head groups of the lipids which are facing inside the cell and I am showing, inside and outside. Why this is inside the cell and this is outside the cell, and you have these fatty acid chains or hydrophobic tails, which are facing inside, in order to minimize the energy.

Why I drew it like this? In order to understand this, I have to take you to a very old experiment, if you remember correctly, it was done by Benjamin Franklin. What he figured out, all of you must have seen this. To explain this, whenever, you go to bathroom or something, and oil spills out, you see a layer forms on top of the water. Say for example, you have a beaker of water and you put some drop of oil. How much ever you try to mix it. It will not. It forms a layer on top of it. Say for example, there is an oil spill in any kind of water, or you know water body, you will see the oil is floating on top of it, because it has a very low density. But, how exactly the interface looks like. Because now, I have mentioned that most of these lipids and everything, they have a hydrophilic group a hydrophobic group.

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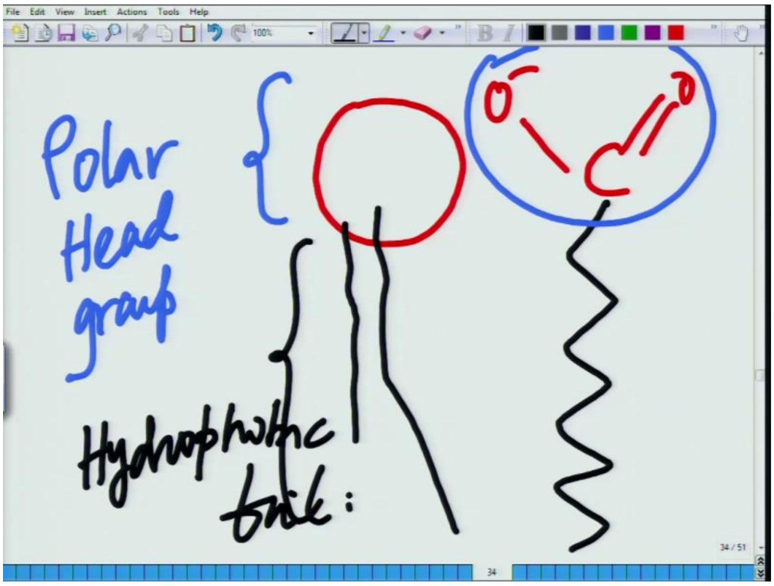

Let me redraw just to answer this question, whenever you talk about. This is the polar head group and this is the hydrophobic tail. When you draw it chemically, it looks like this, C double bonded O minus, and you have this polar tail curve. This part has the ability to interact with water. That is why it is called the polar head group. This one is the hydrophobic tail. Most of the lipids are like this. What exactly happens when oil falls on the surface of the water? There are two central facial phenomena; there two situation. One part of the oil is facing the air and one part of the oil is facing the water.

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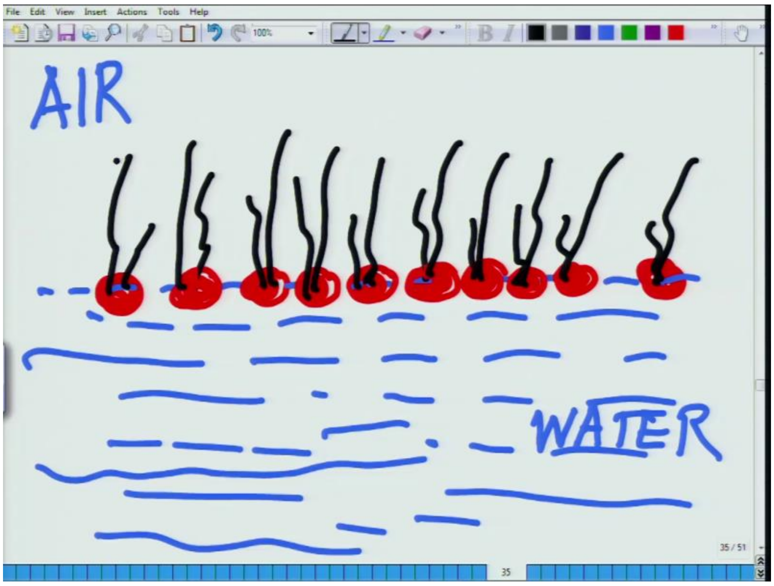

At the air-water interface, say for example, let me draw it. This is water and this is air and you have a drop of water, which is falling. The way it works is that, drop of oil which is falling on the polar head group, which will interact with water, orient themselves like this. Let us draw like this. So, that they orient themselves like this. So, these moieties can interact with water and their hydrophobic tail faces towards water.

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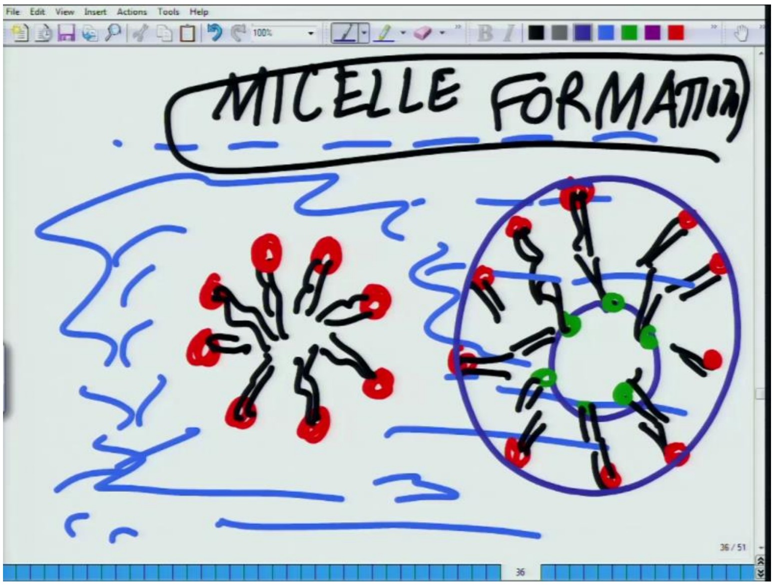

This is how it works. Not only that. If they could form, some of these could even form, something called micelle in water. Micelle is a structure like this. Say for example, there lots of lipids like that. The hydrophobic tail, something like this. This is called a micelle and this is inside water. This is the micelle formation. Then, while I was drawing the cell, why I drew it like this? If you remember, I was drawing it like this. I showed you like, I draw a double layer. Why I drew it like this? In other words, while drawing, I made it like this. Why this was not similar to a micelle? Why it is like this?

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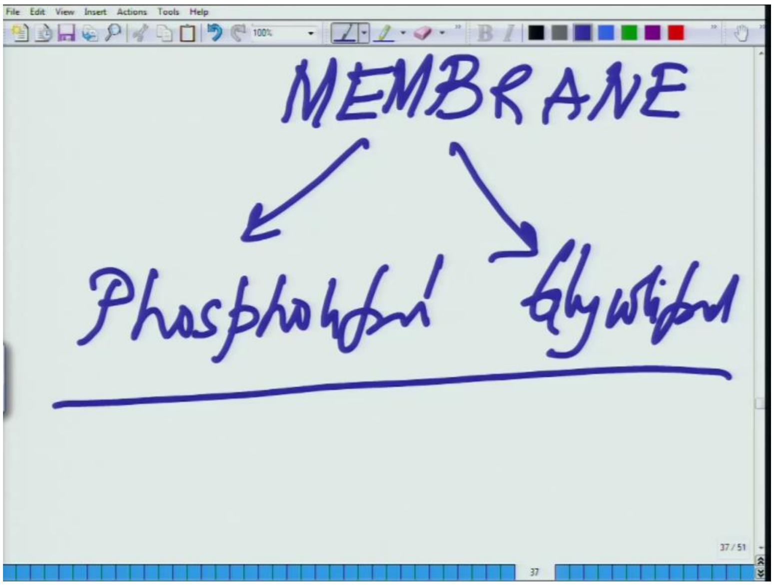

The reason lies, as I told you, the membranes are formed from two major lipids, which are phospho lipids and glyco lipids.

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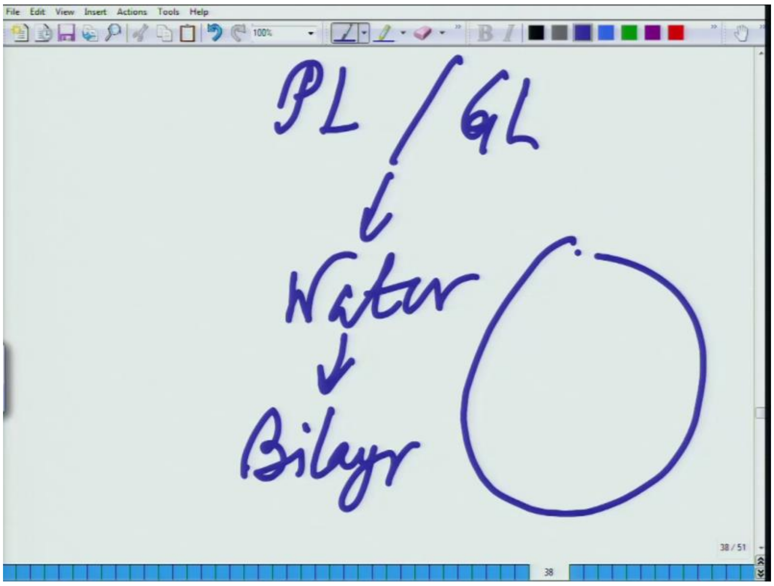

These phospho lipids and glyco lipids, whenever you add them in water say, designate as PL and GL in water, they have a tendency to form bilayer. In other words, one which I was drawing, let me go next page. So, it is like this.

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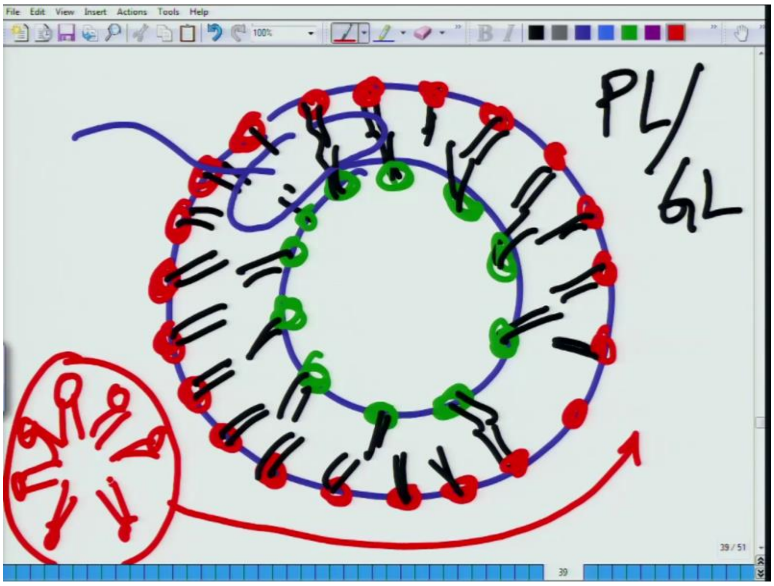

Since, they form a structure like this, these are again the polar head groups.This is their inner tendency. This tendency comes because of certain energetic reason. I will give you an example of other lipids, which does not have a tendency to form like that, which exactly form a micelle. You have to understand the difference between micelle and a bilayer structure. These are the hydrophobic tail. This is a tendency of these phospho lipids and glycol lipids to form like that. Because, these phosphor lipids and glycol lipids, these hydrophobic chains are very bulky and they prefer to form a bilayer structure, instead of forming a single layer micelle structure like this, which I was showing you, just before a couple of minutes back. I was showing you the micelle like structure. This structure is only shown by some of the lipids, like sodium palmitate and these kinds of lipids. They have a single chain.

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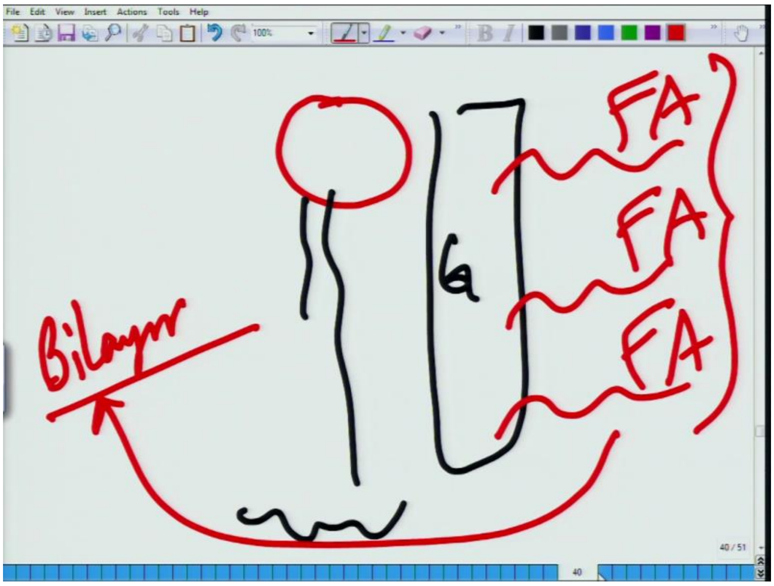

The reason is I told you, that most of them have this kind of structure. They have two tails or in other words, the moiety has a structure like this. This is glycerol and they have this. These bulky chains are the fatty acid. These ones prefer; these kind of structures prefer to have bilayer kind of structure.

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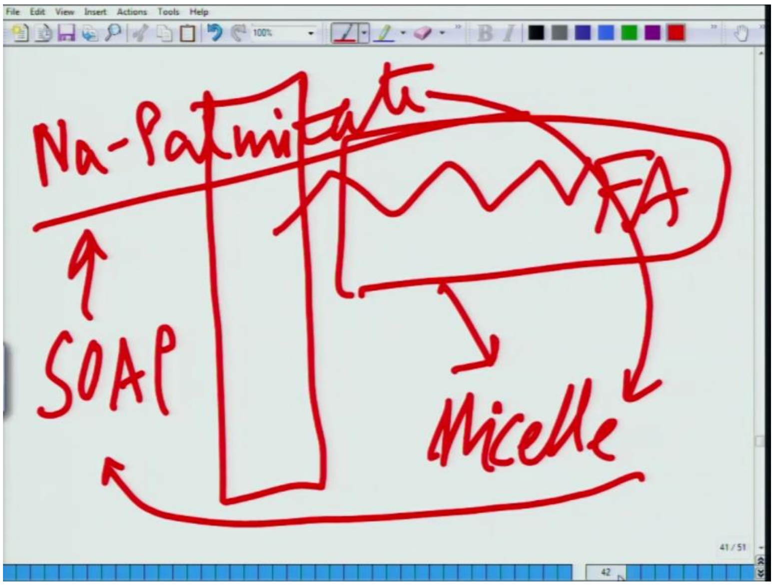

Whereas, if you have fatty acids, which is something like a single fatty acid chain, like this. These one prefer to form micelle. One such example, which is used in soap. In the soap is sodium pamitate, it invariably will form micelle, as compared to phospho lipids and the glyco lipids. This is what I expect from you people, to understand like, these are some of the very basics of the lipid structures, which are very essential in understanding how the membrane is formed, and how it interacts. In order to summarize, I will say there are five different features, which are very essential.

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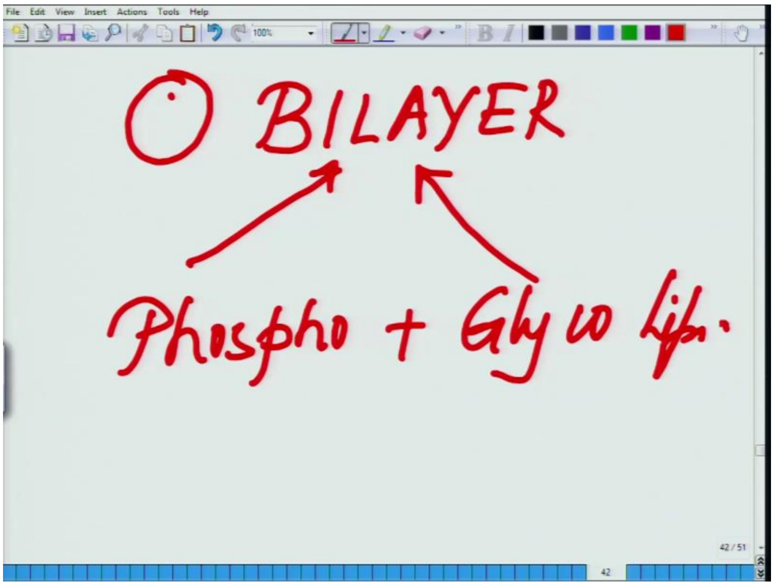

Feature one, which is very essential is this bilayer formation, which is directly linked to the energetic feature of phospho and plus glycol lipids. This is extremely essential for you people to understand.

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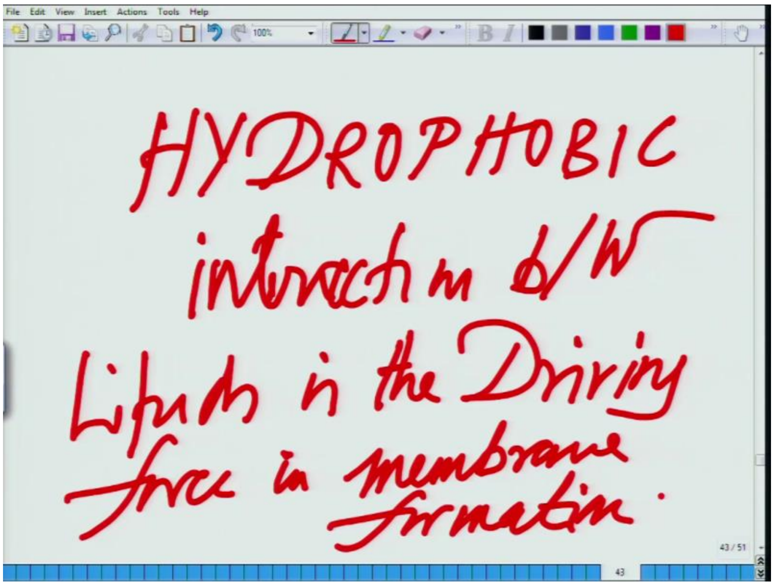

There is a major hydrophobic interaction between the lipids, in order to form the membrane. Hydrophobic interaction between lipids is the driving force in membrane formation. This is extremely essential

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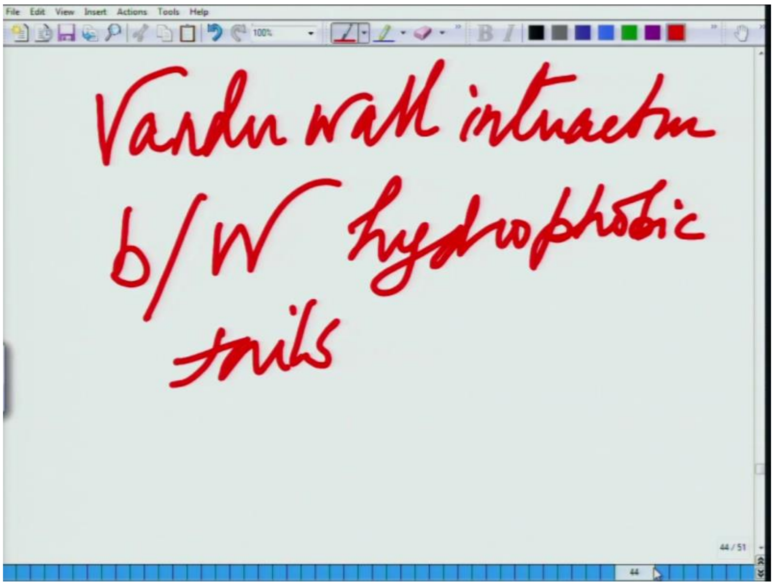

Next thing is that, there is a Vandor Wall interaction between hydrophobic tails. This is also a very critical feature.

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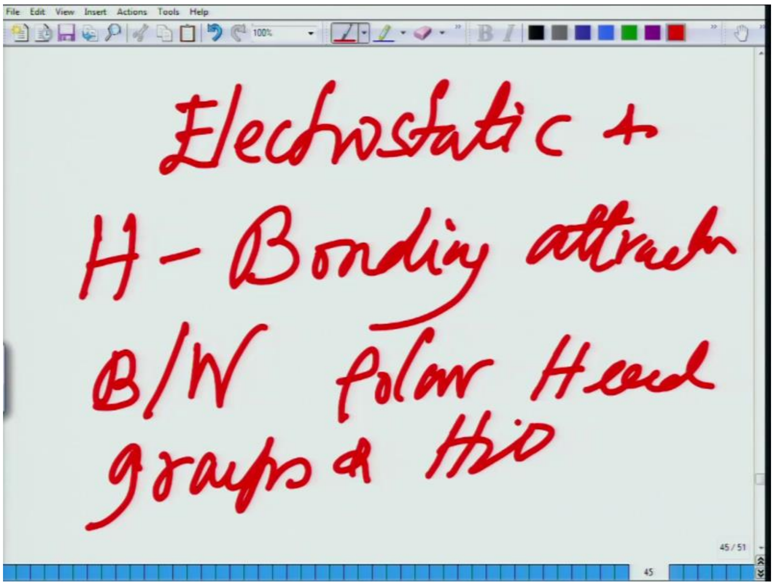

Then, you have electrostatic and hydrogen bonding attraction, between polar head groups and water. This is another critical feature.

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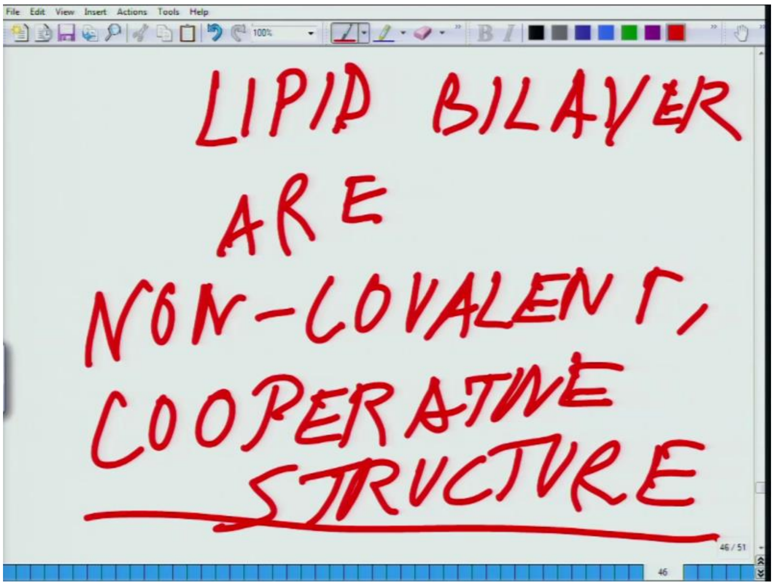

And last, but not the least, if I have to summarize it, I will put it like this; lipid bilayer are non-covalent cooperative structure. This much I expect all of you to understand now. This basic understanding is essential in order to understand the membrane physiology and the membrane process, which are key to our survival, growth and evolution.

Thank you.