Biochemistry
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Lecture-13
Lipids and Membranes - I

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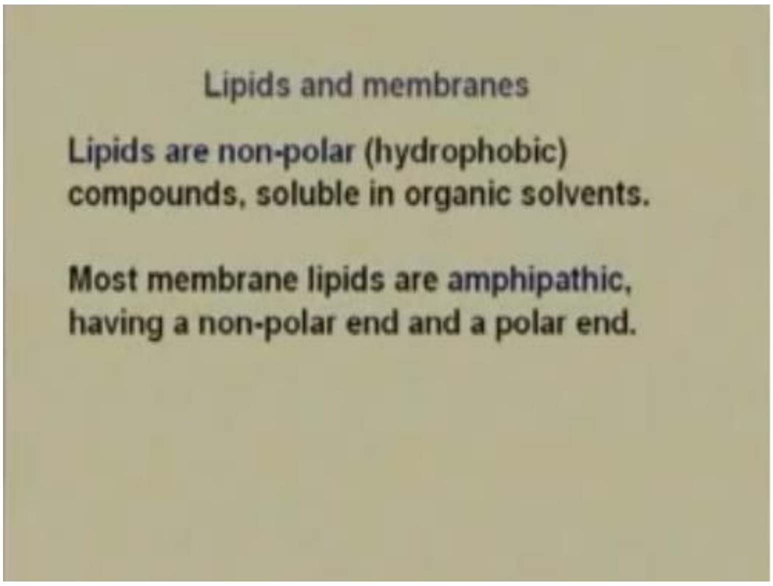

For the compounds that have a polar head group and a hydrophobic tale. Now we're going to understand how these are organized into membranes and what their functions are. So basically what we have anything that is non-polar hydrophobic compounds, soluble in organic solvent is called a Lipid. Now the membrane lipids that we talk about are what are called amphipathic nature, what we mean by amphipathic?

It means that has a non-polar end and a polar end to it. Now the non-polar end arises due to definite chemical moieties and the polar end again arises due to some other groups that are present.

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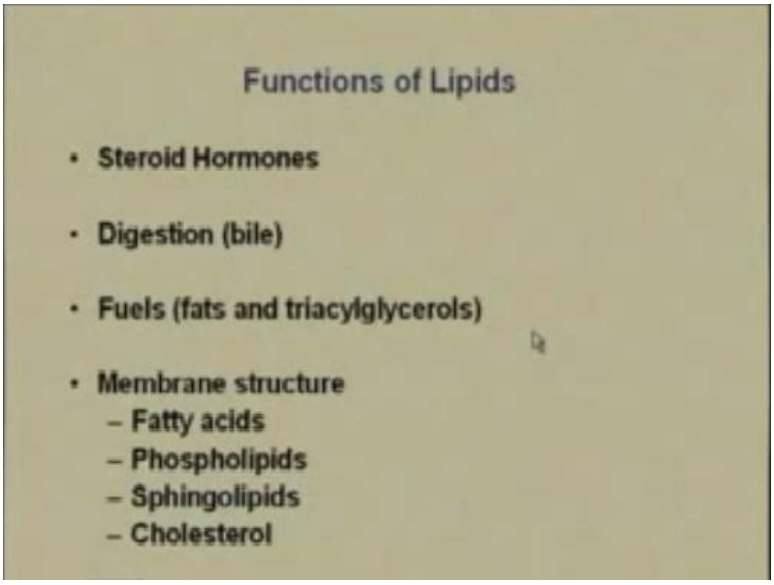

Now if we look at the functions of lipids they play a very important role in a biological cells and biological cell membranes and of course membrane transport which will be doing later on. We have Steroid Hormones in digestion as fats and triacylglycerols which give us the fuel for our bodies and the membrane structure. So lipids are involved in all of these activities starting from hormones to digestion, elements that are present in the bile.

These are all lipid have lipid just their components, the facts triacylglycerols are lipids and in membrane structure which will what will be doing today, we have fatty acids, phospholipids, sphingolipids and cholesterol. Now initially, what we're going to do is, we just study what the different nomenclature and the different types of fatty acids.

Now what we mean by a fatty acid, is a long chain acid. Now in the organic carboxylic group that we speak about we speak of a C double bond OOH being the acid moiety.

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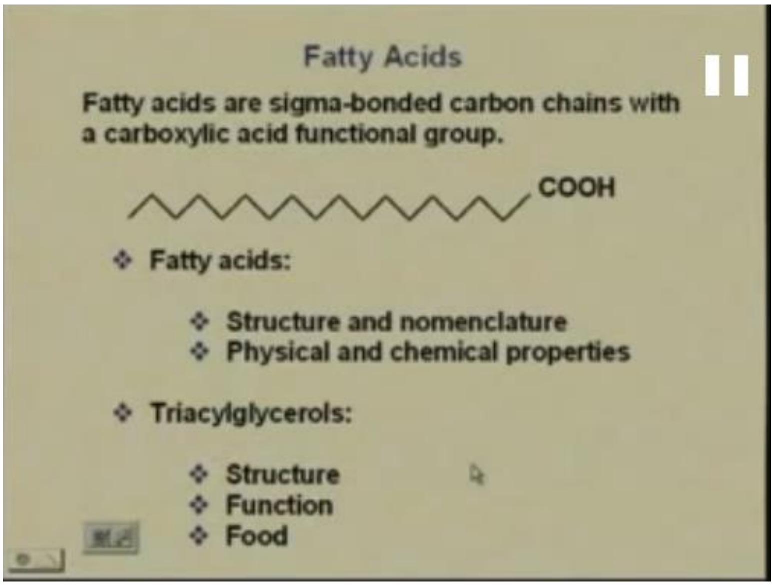

Now what we have here is we have a long chain hydrocarbon with a COOH attached to it, okay. So these fatty acids are sigma-bonded carbon chains, what we mean by sigma-bonds? We have just single bonds here and what do they have at the end? They have at the end a carboxylic acid moiety a carboxylic acid functional group. Now this functional group or this might is going to be in the overall function or overall structure of lipids that forms these membranes.

If we consider the Fatty acids, the first thing that we are going look into is the structure and nomenclature as to how they are identified and then the physical and the chemical properties of the fatty acids, then we going to go into a study that Triacylglycerols and see how they have play an important role in the structure and function and the formation of lipid membranes.

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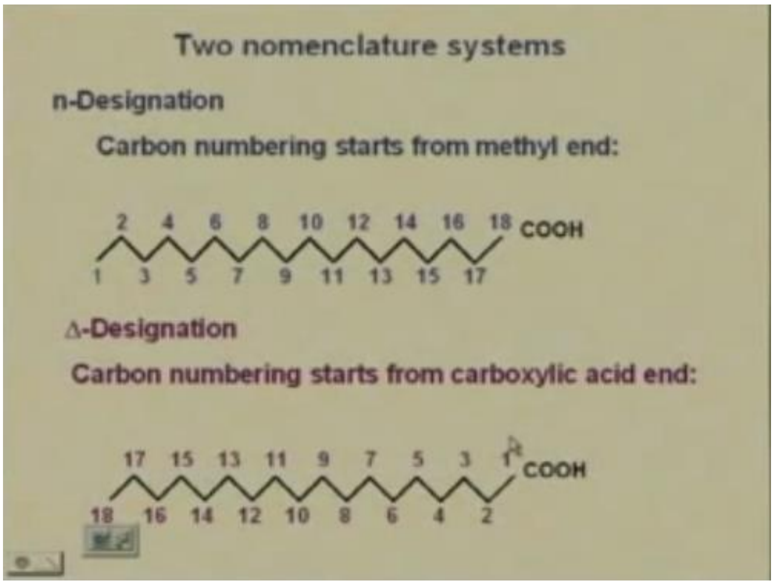

Now the first thing is about a nomenclature. Now the nomenclature of fatty acid actually follows two types, one is called the n-Designation another is called the delta designation. In the end designation as you can straightaway see the numbering is from the extreme n away from the carboxylic acid group. So, in this case the number is from here 1,2,3,4 and so and so forth. For the delta designation, the numbering begins from the carboxylic acid end.

And it is this nomenclature or this designation that we will be using, the delta designation. So if you are to write any particular fatty acid write the structure of any particular fatty acid there will be a specific nomenclature that you will follow and that nomenclature will be the delta designation where the numbering will begin from the carboxylic acid end, not the end of designation. Now, how does this help us?

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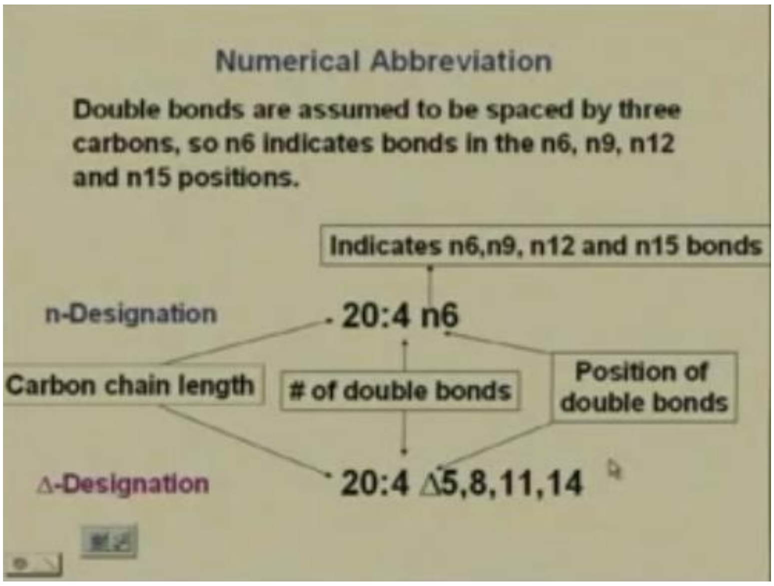

In the next slide, we see the nomenclature how we could write, this is a fatty acid in the end n-Designation and what I have below here is a fatty acid in the delta designation. Now from this nomenclature you should be able to write the fatty acid. So we have to know what each of these numbers mean. The first number that you have here is the Carbon chain length, so it tells you how many carbon atoms you have.

After the colon you see another number, so this 20 means that the Carbon chain length is 20, the number after the colon designate the number of double bonds present, so we have in this case we have a Carbon chain length of 20 and the number of double bonds at 4 and now you can tell me this is actually the position of the double bonds, okay. So the number that we have at the end is the position of the double bonds.

The delta 5 means the double bond is between 5 and 6, 8 means it's between 8 and 9, 11 means between 11 and 20 and 14 means between 14 and 15. In the n-Designation that usually just one number put because usually when we form or when the fatty acids are biosynthesized what happens is they form in specific units, if you notice here every double bond is after three carbon atoms, it's 5,8,11,14.

So in the end designation only one is specified which tells you that there is going to be an another one at 9,12 and 15 and it is opposite to this because obviously the numbering is opposite then in the delta designation. So the double bonds are assumed to be spaced by three carbons, so here in the end designation only n6 is specified and nothing else. But, in the delta designation the position of the double bonds is written explicitly, where we now know that if this is a nomenclature it means that you have a Carbon chain length of 20.

There are 4 double bonds and the position of the double bonds are 5 and 8, and 8 and 9, 11 and 12, 14 and 1, okay.

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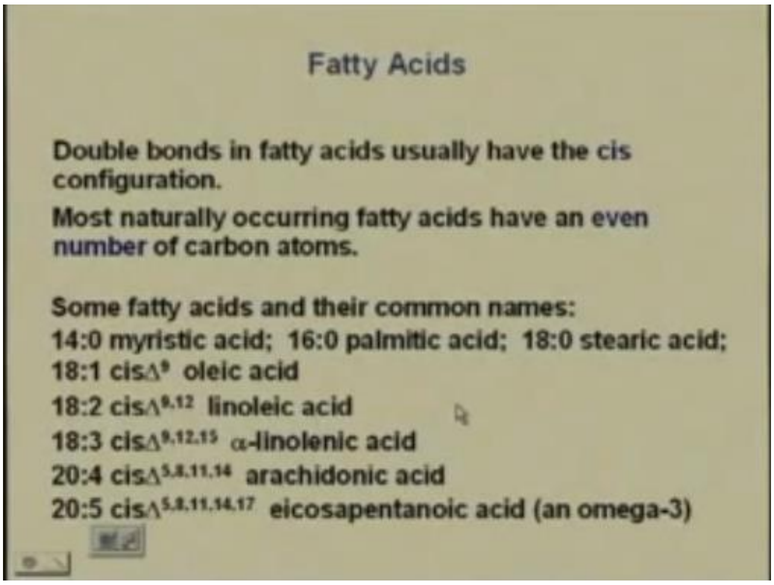

So, if we look at a set of designation then we have usually another thing that we should mention here is that the double bond that we see in the fatty acid usually have a cis configuration, and most naturally occurring fatty acid have an even number of carbon atoms because the way that they are biosynthesis is they come in pairs of carbon atoms, okay so if they come in pairs of carbon atoms all of these are usually even numbers.

You do not see an odd number fatty acids because when fatty acid biosynthesis occurs it comes in pairs of carbon atoms. Now we look at just some fatty acid and their common names 14:0 is myristic acid. So these are all the delta configurations. So you should be able to write, what myristic acid is? What is it? It just a long chain, a hydrocarbon chain with 14 carbon atoms, okay. And you know where—no don't need a numbering in this case obviously because there are no double bonds.

So we have myristic acid, palmitic acid, stearic acid, then we go to oleic acid. It is 18:1 cis, now cis is, isn't usually put in just the delta 9 is sufficient because most of them are cis anyway. So 18:1 delta 9 means oleic acid is an 18 carbon fatty acid with one double bond between 9 and 10, that's a simple. So now you should- so the one that I had in the previous page is actually arachidonic acid.

Okay, it was 20 with 4 double bonds at 5,8,11 and 14, eicosapentaenoic acid which is an omega-3 fatty acid has an additional double bond at position 17. So when we write this, so this is sufficient this nomenclature is sufficient to tell you how to write a fatty acid, okay. So this is basically the nomenclature of fatty acids, and we going to see how we can use these fatty acids in forming our lipids.

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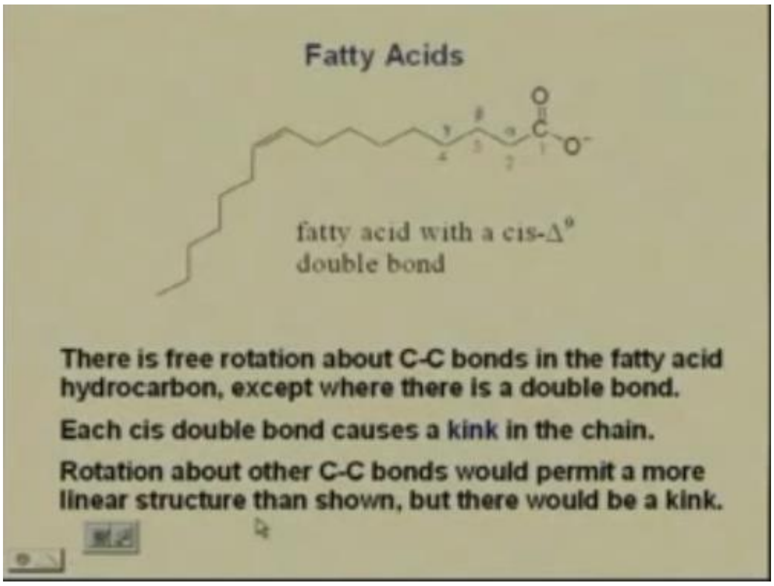

Okay, so what happens if you have this cis double bond? So here we have a single double bond, you see that how the Carbon chain has not change direction, right? If this cis, or if this double bond did not exist it would have been nice straight chain and there could have been rotations above the single bonds. But, when we have it in the cis configuration then what happens is there is a break in the chain because of the cis configuration.

So you have what is called 'kink' in the chain, okay. So instead of having a normal long chain that you wouldn't and free rotation above the single bonds each cis double bond causes a kink in the chain. So if I had another cis double bond at this position this part of the fatty acid, part of the chain would fold back so I would have a kink in the structure. So, I have a kink in the structure due to the fact that I have double bonds in the hydrocarbon chain.

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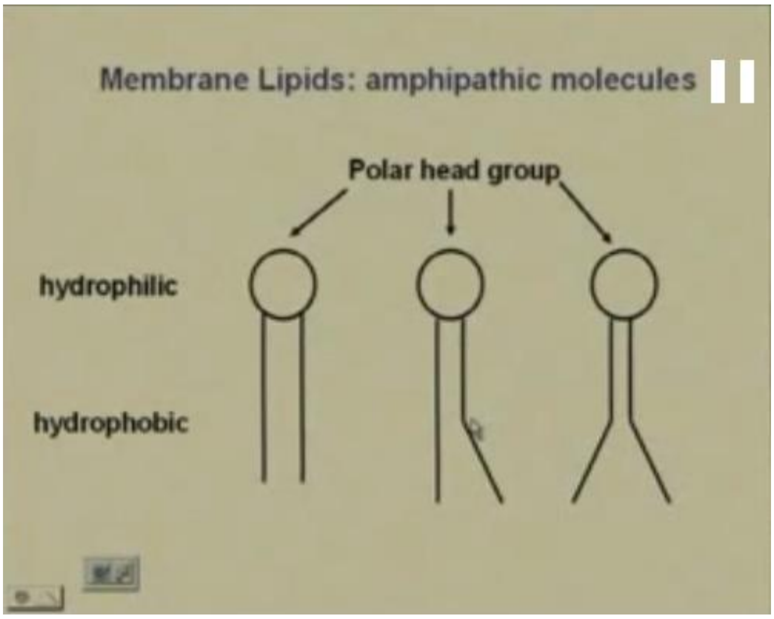

So what do we have? When we have these membrane lipids now, this is something we are going to study in detail later on. These are my fatty acid chains. So what is going to happen is I am going to have a polar head group, we will see what those polar heads group can be and my hydrophobic tale if it is a straight chain fatty acid it will look like this, if it happens to have one fatty acid that has a kink to it, it is going to be shaped like this, okay.

We will see how I am talking about two fatty acids link to a single polar head group in a moment. But when we're talking polar head group and different fatty acids when they link together you see how you can change the structure of the lipid because of the type of fatty acid that is being attached to the polar head group, okay. So you are basically changing the structure depending on the choice or the type of the fatty acid that you are considering.

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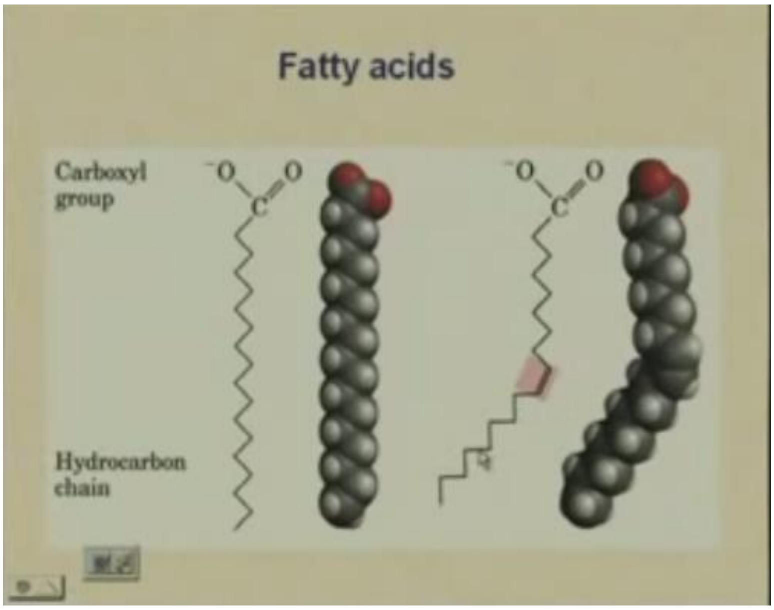

So basically if you look at fatty acids this would be the structure where we would have a carboxylic group here so this would be the polar part of it and if we have a long chain it would be a smooth long chain a straight chain. If you happen to have a cis bond here, what would happen? The chain would get bend, okay so you would have what is called the kink and you recognize that if you had another cis bond here what would be happen now, it would twist even more.

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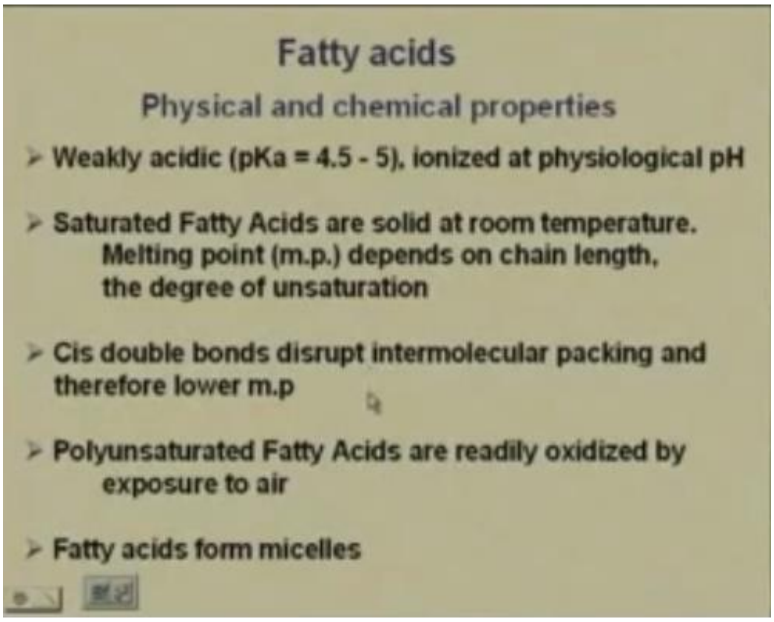

Okay, now some properties of fatty acids. Here are some physical and some chemical properties. Fatty acids are weakly acidic in nature. Weakly acidic where the (pKa = 4.5 – 5), which means that there are ionized at physiological pH because physiological pH is 6.7.4.

Saturated Fatty Acids are solid at room temperature. The melting point you understand is going to depend on the chain and definitely the number of double bonds present.

Okay, on the degree of unsaturation, we will see how that is going play an important part in our lipid foundation membrane lipid. So we have Weakly acidic fatty acids, the Saturated Fatty Acids are solid at room temperature. The Melting point depends upon the chain length and the degree of unsaturation. The Cis bonds you understand with the kink in the cis bonds what happens, is it disrupt intermolecular packing, okay so it lowers the melting point.

Okay, because if you had straight chains that will normally completely very well organized you would have a higher melting point. But due to the whole presence of the cis double bonds the intermolecular packing of the hydrophobic chains is disrupted it is broken and that lowers the melting point. The Polyunsaturated Fatty Acids that you see in a lot of vegetable oils that you consume let say that they are “Puffa” that’s what it’s called Polyunsaturated Fatty Acids.

They are readily oxidized by exposure to air. And these fatty acids can form micelles, okay we will see you know why can form micelles because they have a hydrocarbon and it has a polar head group to it okay. So these are the basic physical and chemical properties of fatty acids, what we have to remember is that they are Weakly acids, Saturated Fatty Acids are usually solid at room temperature.

And the melting point is going to depend upon the number of carbon atoms you have and on the degree of unsaturation and the more the number of cis bond that you have the lower the melting point is going to be because you are going to disrupt the intermolecular packing between the hydrophobic chains.

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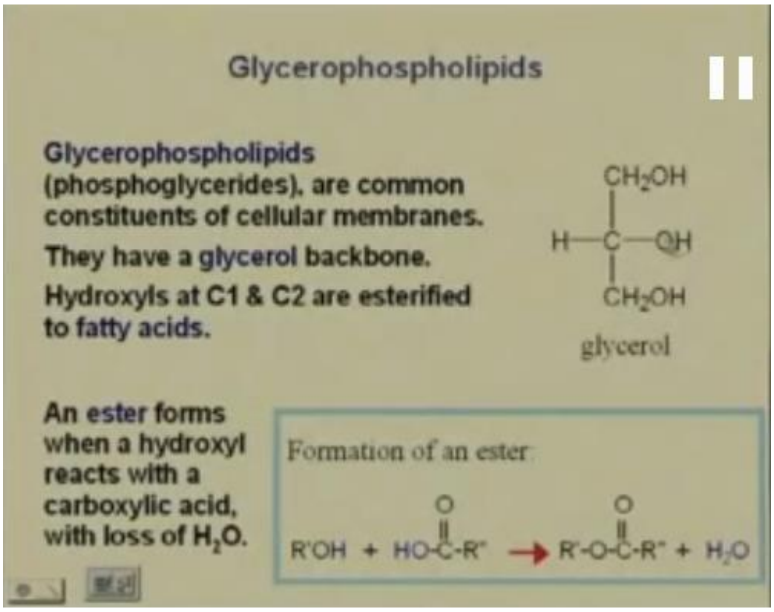

Okay. Now we are going to come to what are called the Glycerophospholipids. What did this means? We have glycerol. Glycerol tis CH_2OH, CHOH, CH_2OH, okay. Now, Glycerophospholipids are what comprise lipid membranes. They form or they are the constituents of cellular membranes. Now we recognized that these OH groups that you have here can be esterified by acids. What is an esterification reaction?

We have R'OH and RC double bond OH with the removal of water we form an OCO an ester formation. That means that these H's if they react with fatty acids can do what, they can be esterified and I can have to this glycerol a long chain attach to either this hydrogen or this hydrogen or this hydrogen. Usually, there are two fatty acids attached to it, which is why I have two lines sticking out from the polar head group.

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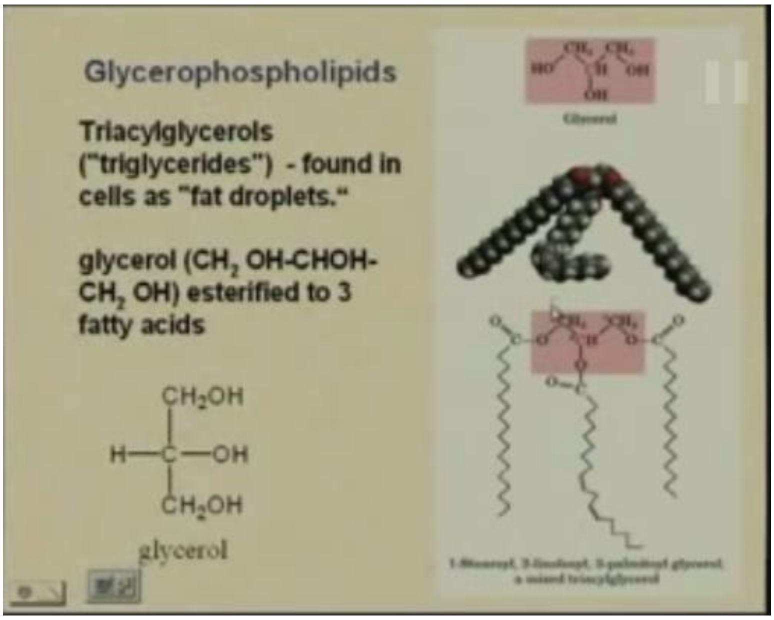

So what do we have, we have the Hydroxyls at C1 and C2 that are esterified with the fatty acids. So what happens? So we have our glycerol, it is in this case the one that I show you here is Triacylglycerol's which is what comprises the fat droplets that we have in cells. If you see there are Triacylglycerol's, or "triglycerides" test that have to be performed in blood to see whether you have an appropriate triglycerides content.

If you have more fat droplets, then you have then you have a fat restricted diet. So this is what a Tricylglycerols what it looks like, what do we have here, here is the structure of the glycerol, we have three OH groups here. If each of them number one, number two and number three are each esterified this is what it is going to look like.

So in the first carbon atom and in the third carbon atom we have straight chain fatty acid that have been use to esterified OH groups of the glycerol, the extreme OH groups of the glycerol have been esterified with straight chain fatty acids here. In the middle, we straight away know that this has now not only one but it has two cis double bonds which is why it is even then bend further than the one I showed you previously.

If you look at the structure here, this is only acid which has been used we have one cis bond here and another cis bond here. So it has change the structure of the hydrocarbon chain into making it more disrupted, it is more (()) (19:17) in the sense. Now we are going to see how we can change the properties of the groups here and then change what lipids or what the glycerol – Glycerophospholipids are actually made of.

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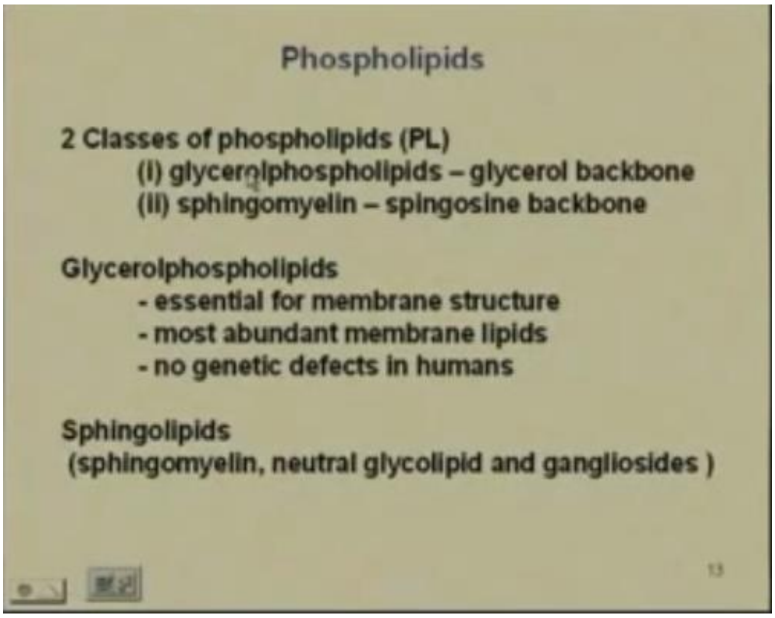

Okay, what we have i.e. are called Phospholipids. What are these Phospholipids? In the two classes of phospholipids that are presents these form cell membranes. We have glycerophospholipids that have what is called glycerol backbone just like I showed you. We have sphingomyelin that forms from a sphingosine backbone and in this case this actually forms a lot of the membrane each of these will form a lot of the membrane.

And this phospholipids usually refer to as PL. Now what is essentials of these? They are extremely important for membrane structure; they are found in membrane lipids. And we will see how these -- what these structures actually are. So what we need to know is that types of phospholipids and they are essential for the membrane structure and they are found in membrane lipids.

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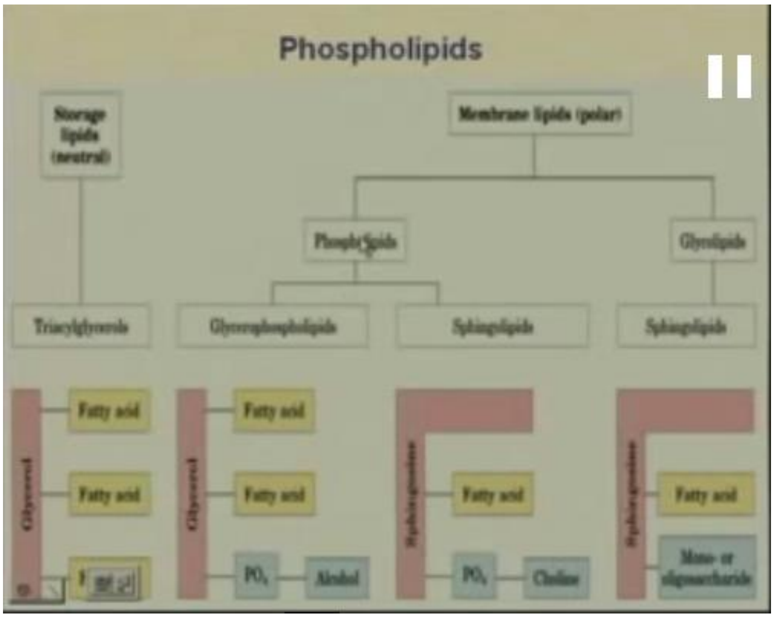

Okay, this is the breakup. What we have here is we have Storage lipids. Storage lipids storage in terms of fat droplets. What are the fat droplets, they are Triacyclglycerols, so what we need to know is the storage lipids which are neutral in nature have three fatty acids attached to the glycerol? Okay, we have membrane lipids, in the membrane lipids we have Phospholipids and Glycolipids.

In Phospholipids we can have glycerophospholipid it just a breakup tree. So the membrane lipids are polar in nature, because they have a phosphate group attach, will see what it means in a minute. Phospholipids are Glycerolipids, Glycerophospholipids are Sphingolipids and Glycerolipids are other sphingolipids, Glyceo means you have sugar whenever the word Glyceo comes in a prefix Glyceo means there is sugar present.

So if we go back to the Phospholipid breakup we have storage lipids that are triacylglycerol fatty acids, we have membrane lipid that are phospholipids or Glycerolipids; the breakup of phospholipids is glycerophospholipids or sphingolipids where the backbone is basically different. Now will study this in a bit more detail.

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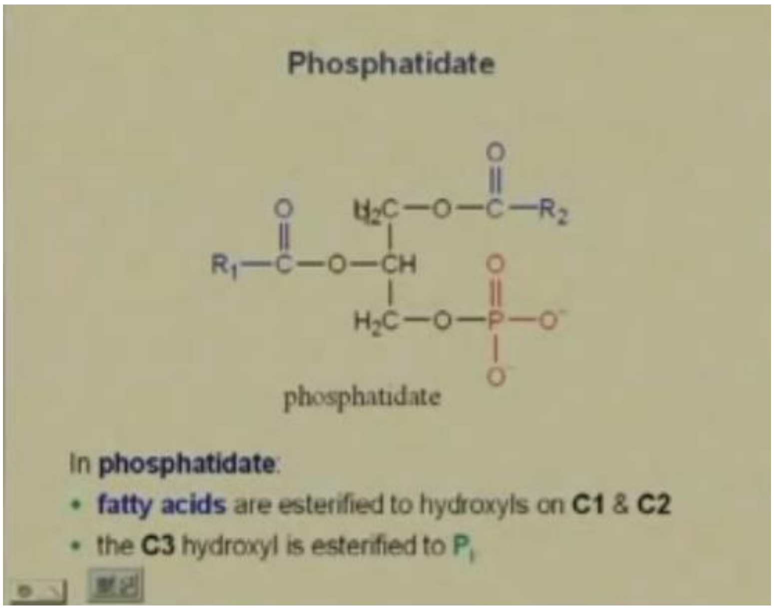

This, you recognize a back part here is part of glycerol, CH_2OH, CHOH, CH_2OH. Now what is happen at the first two carbons is the C1 and the C2 have been esterified by fatty acids. So we have long chain fatty acids in both cases. The third carbon has been esterified with the phosphate remember that is also an acid. So we have two of the carbons esterified with fatty chains and one with a phosphate, this is called a phosphatidate.

So what is the basic structure, the basic structure is glycerol. The two carbons of glycerol have been what esterified to with two fatty acids and the third with phosphate. So we have a phosphatidate or phospholipids. So this is what it looks like. What do we have?

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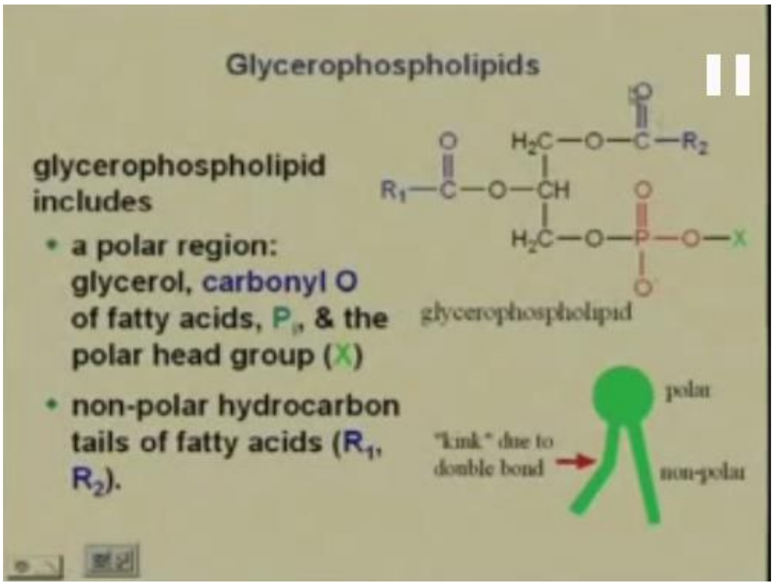

We have a fatty acid on the first carbon, we have a fatty acid on the second carbon and we have a phosphate on the third carbon. Now, the phosphate again is an esterified, okay. If the phosphate again is esterified by this X group, this is where we can change the type of glycerophospholipids that we have. So where can I make the changes. We have the basic structure of glycerophospholipid that is going to be the glycerol.

We have one fatty acid linked on the first carbon, a second carbon linking an another fatty acid. So obviously we can change the type of fatty acids that we have. As soon as I change the type of fatty acid the type of lipid is going to change. Then I have an esterification on the third carbon atom with phosphate and I have a polar head group which we will see how that affects it.

So what do I have, where is my polar head group? It is here, here the oxygen, phosphate and so on and so forth. And where are my chains? R1 and R2. So what do I have, I have the basic structured of the lipid that is going to look like a polar head that is this part here and the R1 and the R2 are these chains, okay you understand that the structure looks like. We have the overall glycerol, two of the OH has been esterified with long chain fatty acid which is why I have two legs to this polar had group.

And the polar head group forms because of the phosphate esterification and an additional polar head group. Okay, so this is the basic structure of a glycerophospholipid. Now what can I change here, I can change type R1, I can change R2, I can change X, in that I will be changing the complete type of glycerophospholipid that I have and we are going to see how we can do that. Okay so this is our structure.

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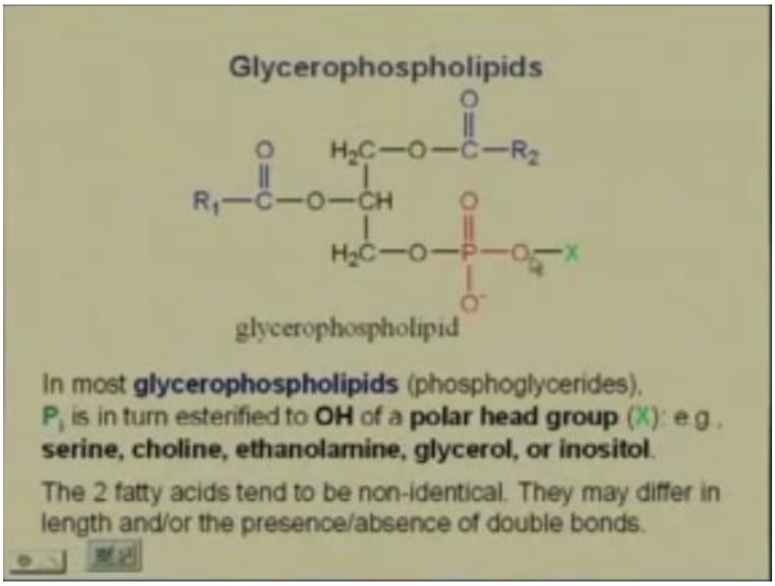

So we have the PI OH what is happening to this OH? It has been esterified again it can be esterified with serine, choline, ethanolamine, glycerol or inositol. There are different groups that can be used to esterified the phosphate in a phosphoglyceride. And the two-fatty acid that we have R1 and R2 are usually not the same. We will see why later. So how can they be different?

They can be different in their length, they can be different in the number of double bonds, they can be different in the location obviously of the double bonds, so that is where we have a differences R1, R2, X. So what are these differences?

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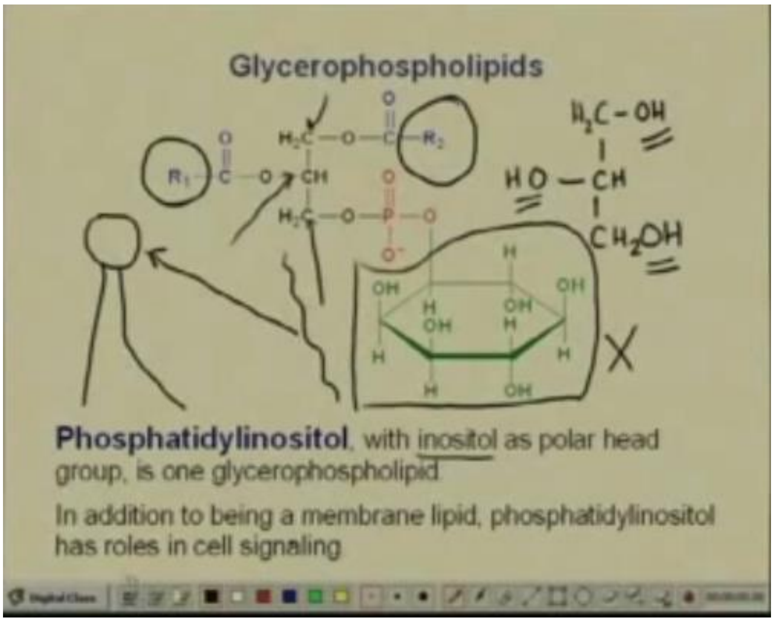

This is phosphatidylinositol. So you recognize now the glycerol mighty. Let me show you here clearer. Okay so here is our glycerol mighty. So this is one carbon atom, this is the other carbon atom and this is a third carbon atom. So what was our glycerol structure? C-OH, then we had CH OH and again we had CH2OH. This has been esterified. This has been esterified. So we have long chains here and in this case we have esterified with the phosphate link to the phosphate again now is another group.

This is the X that I showed you in the previous slide. So it is this group X but in this case is inositol. Okay, so what do I have? I have—now you recognize when you have all this number of OH here and the phosphate here and the negative charge here what does it comprise? It comprises the polar head group. So it is this part that forms the polar head group. And what is R1 and R2 forming? The tail.

It can be different depending on the type of R1 and the type R2, okay. So this is the basic structure of a glycerophospholipid. Now what can we change, we can change inositol to make it something else. So Let us see what we can change it to.

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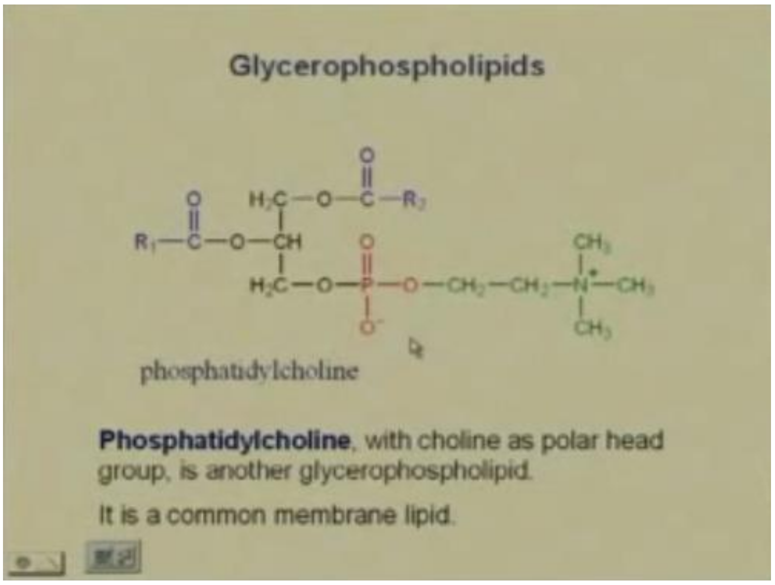

We can make it choline. Again the basic structure is exactly the same, I have R1, R2, I have the phosphate link to the phosphate. I have another X, what is that X? Choline. So I have instead of phosphatidylinositol I have phosphatidylcholine. I can also have phosphatidylethanolamine. I can have phosphatidylserine. Each of these the different you understand is going to be just in the X group in this case.

So we can have identical R1's and R2's for phosphatidylcholine, phosphatidylserine, phosphatidylethanolamine and so on and so forth. Okay, so these are the different types of glycerophospholipids that we can have. What you need to remember is the basic structure is a glycerol, you have two fatty acids R1, R2 you have a phosphate and the phosphate is linked again to another polar head group that is going to result in polar head group to your lipid.

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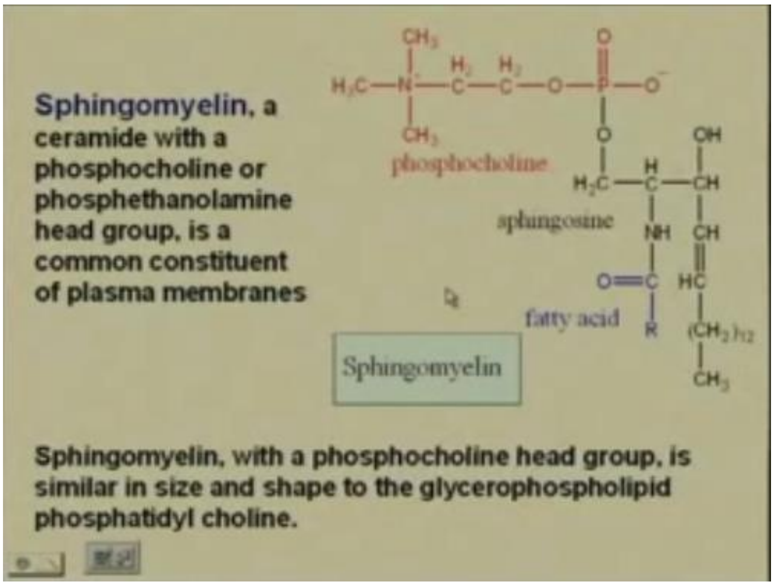

A Sphingolipids. What is a Sphingolipids? Now the Sphingolipids, this is a structure it is based on the structure called sphingosine. Now this is the structure of sphingosine. What you see here, is you have a CH2OH, you have in the middle CH-NH3+ and in the last carbon you have a CH-OH to which it is linked a long hydrocarbon tail. So this is the basic structure of sphingosine.

Now what can happen here is -- what groups do we have now-- we have a long carbon chain as it is. Okay so by default sphingosine come with a long hydrocarbon chain. It has a polar region that constitutes an amino group, it has a NH3+. Now what can happen with the NH3+ in the fatty acid? It can form an amide, right. So what can happen here is you see in the part here that we have an R-C double bond O-NH.

Because we have just like an amino acid linked to an NH3+ give you what an amide you can have an amide formed here. So the amino group of the sphingosine that can form an amide bond with the fatty acid gives you what is called a ceramide. Have you heard the word ceramide before? they sell you shampoos with ceramide in it. If you look at the advertisement of shampoos they will tell you that ceramides are present in it, okay.

This is what is a ceramide. So what do you have in a ceramide, you basically have a sphingosine, what is a sphingosine it is, the sphingolipids are going to be derivatives of this, it has nothing but to two it has a long hydrocarbon chain, there is a NH3+ attached to it and an OH attach to it. Now this already has the long hydrocarbon chain attach to it? So what you can have is you can have this NH3+ form an amide with another fatty acid.

So what you are going to have? You are going to have two long carbon chains here, okay so that is exactly what you have. So we have ceramides that are usually include a polar head group and they esterified to the terminal OH of the sphingosine, that is. Okay, so what did we have? You recognize a basic structure of the sphingosine now? This is the basic structure of the sphingosine the one in black. This is the long carbon chain that you had.

This is the long carbon chain. So this is the sphingosine moiety. This is the fatty acid attached to it to form an amide. And what do we have here; we have -- remembered there was an OH here so this can attach to another group forming a sphingomyelin. So we have what is called a sphingomyelin which is a ceramide with a phosphocholine. What is a ceramide? A ceramide is when you have OH here and the amide here and this sphingosine as it is.

So in the basic structure of the sphingosine if you have the fatty acid linked to form an amide it is called a ceramide. In this case, when you have phosphocholine to form a head group here this forms what is called Sphingomyelin. So this is after formation of a ceramide. So you have an OH group, initially this was an OH it is now linked to phosphocholine to form what is called Sphingomyelin, okay so that is basically it. Okay.

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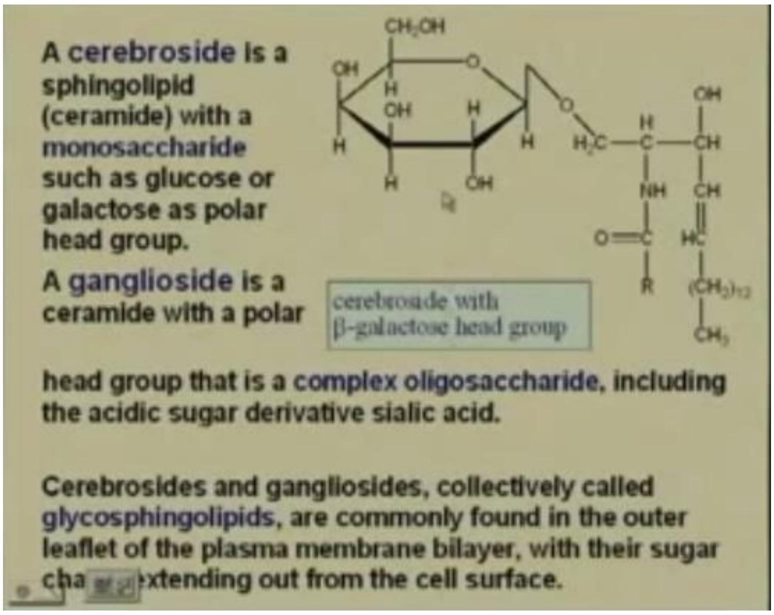

Now again, there is one another thing we need to now. Again we remember what is Sphingomyelin and what is Ceramide is. What is a ceramide? A Sphingosine with the fatty acid with OH. Now you have to recognize that H can have replaced. If you replace this H with phosphocholine you have sphingomyelin. If you replace it with the sugar, you have what is called a cerebroside. It is just nomenclature, all you need to know is you have a glycerol.

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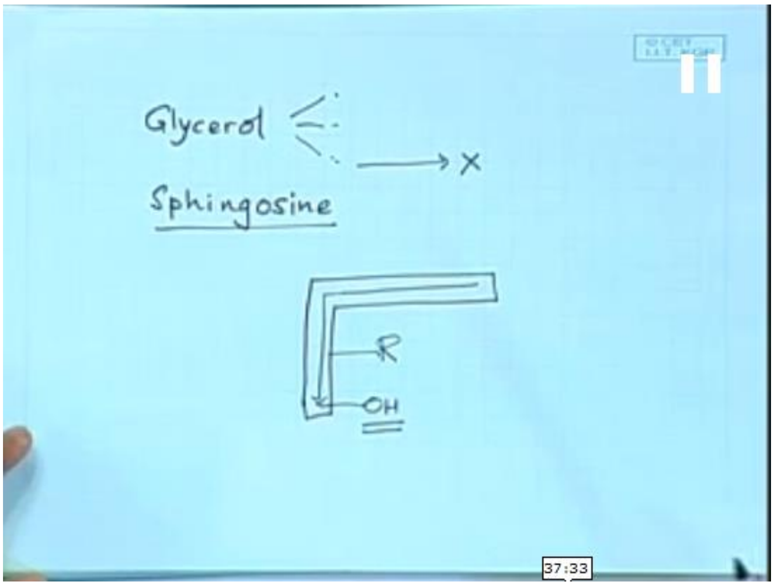

Let us consider here, you have glycerol, you have sphingosine, these are the two backbones, that’s it, okay. What you have is you have three OH groups here, right. If three of them are fatty acids, you have a triglyceride**.** If two of them are fatty acids one is phosphate and you have one glycerophospholipid. If that phosphate again is attached with another X you have a series of lipids.

In Sphingosine, you have a different type of, you have basically a shape like that. Because you have a long carbon chain in the structure of sphingosine itself. What you have here? Is you have a fatty acid attached in forming a ceramide. Then this OH can be linked to a sugar to form a cerebroside it can be linked to a phosphocholine forming a sphingomyelin. Okay so that is the basic structure of all these.

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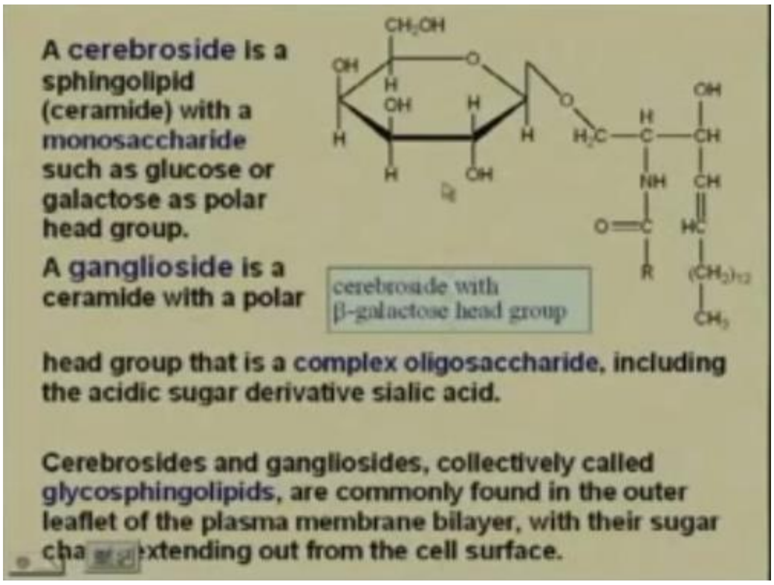

So we can have a cerebroside if you have the simple sugar or you can have a ganglioside when you have a complex oligosaccharide attached to it. Okay, it just nomenclature. They are usually found in the membrane bilayer which is why we consider all the different types of possibilities of the sphingolipids or the lipids themselves. Okay now what can we do with this.

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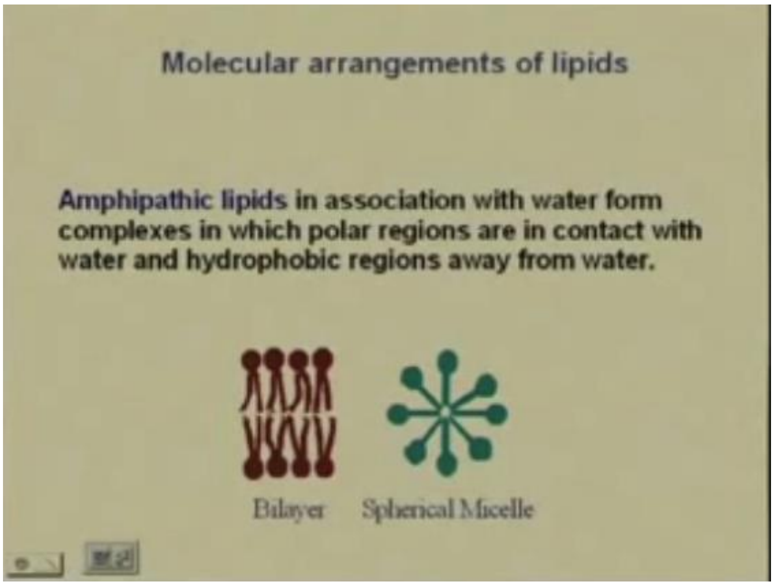

If we look at the molecular arrangements of lipids you know that they can associate with what because the cytosol or the cell itself is embedded in water, embedded in the blood, embedded in the cytosol. So what is going to happen is, the hydrophobic tails will never be in the cytosol, okay. So we have to have what is called a Bilayer. So it is this polar part that is going to be say outside the cell, this polar part this is going to be inside the cell.

So we have a Bilayer that has polar head groups and either deduction so the Amphipathic lipids in association with water will form complexes in which the Polar Regions are in contact with water and hydrophobic regions are away from the water. So it is a very smart way of forming the lipids where you have a strong bilayer which is not going to allow everything in and out of the cell.

But at the same time it is going to be extremely important in the characterization of the lipid bilayer. Now we, there is another way we can organize this, how is that? In a spherical manner. Now what do we form in the spherical manner, we formed what are called spherical Micelles. Now what are these micelles? These micelles have polar head groups outside and we have the hydrophobic tails inside.

Now we can also have what is called a reverse micelle. What is a reverse micelle? Where you have the opposite of this, if you put this in an organic solvent, what is going to happen if you put this spherical micelle with the polar head group in an organic solvent it is going to reverse and the polar head groups are now going to be in the center and the hydrophobic tails are going to be facing the hydrophobic or the organic solvent. So we have what we called the reverse micelle or the normal micelle.

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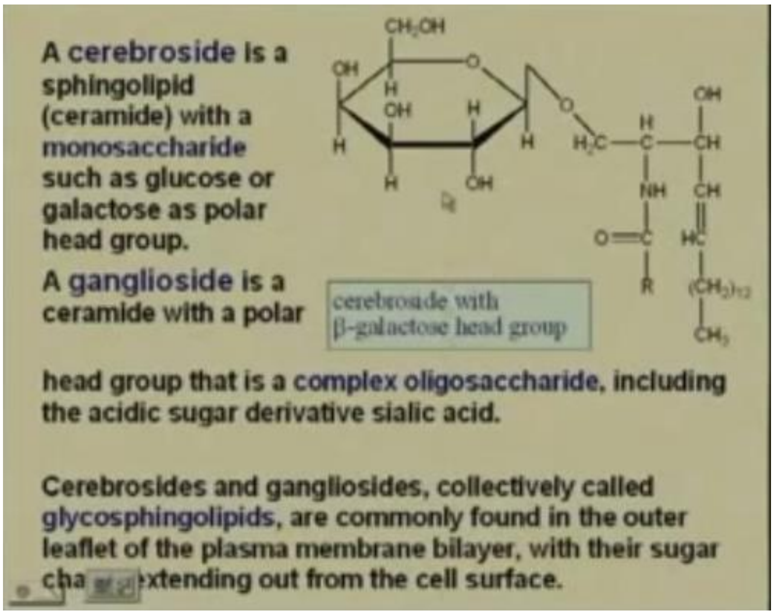

Okay now, if we just go back to this once more when we have a cerebroside or a ganglioside some structure like this form a micelle then we have a long fatty acid chain at the R group. We have another long hydrocarbon chain in the sphingosine moiety because of the sphingosine structure is same. So when this forms a micelle we expect this part to be the polar head group of the surface and these two to be the legs of the structure.

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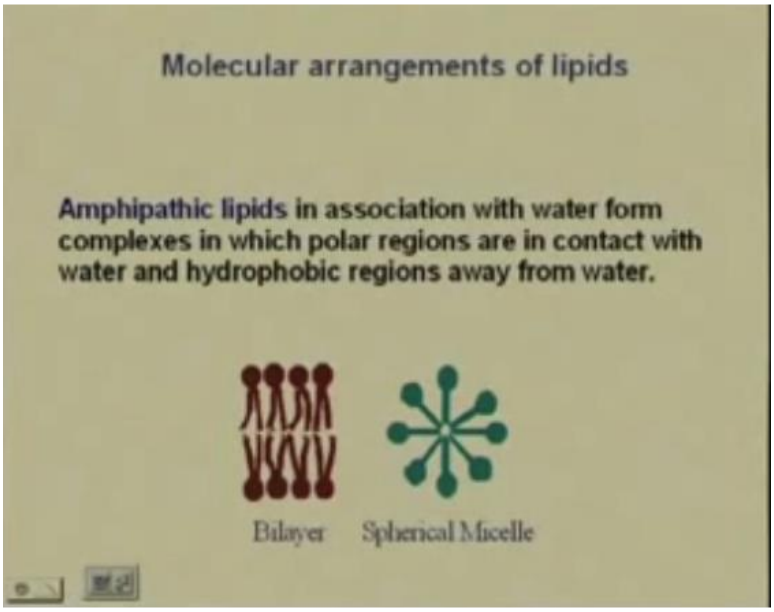

So the structure that we have here is basically going to be the bilayer the two long chain. In case of a glycerophospholipid both of these are fatty acid chains. But, in case of sphingolipid one part is the hydrocarbon chain that belongs to the sphingosine and this is the ceramide the amide part that has been linked with the OH – not linked to the OH it is linked to the amide of the spygocin to form and amide.

So we have one fatty acid and one sphingosine hydrocarbon chain here and so the same thing that we would have here.

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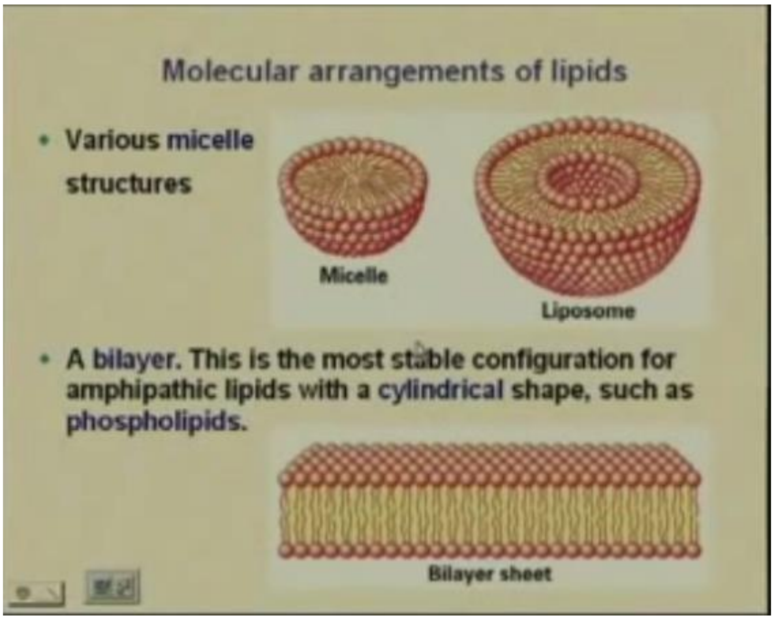

So what are the structures that you can have? This is a micelle. Now micelle is obviously not two dimensional, it is three-dimensional. So it actually looks like this. So this is just like half of it part you can see. So we have different types of micelle structures. What are these micelle structures? So all of these red balls that we see here red fears along the surface all polar head groups and all the chain that are inside are all the hydrophobic chain that we see.

Now when we consider what a liposome is okay because we have to consider the way the transport of material occurs in the body. If you have micelle and you have a polar ingredient or a polar substance that have to be transported, you understand that it is not going be possible for this particular micelle to transport it, why because it has a hydrophobic core right, a hydrophobic core to it and it would possible to transfer a hydrophobic component.

But if it happens to be a polar part it would be difficult to do so, so we have the formation of liposome. What happens here is you see there is a lipid bilayer sort of a thing that forms a membrane and inside we have a polar center okay. Now the reason why I am telling you this is this is used for a lot of drug delivery. When you have drug delivery or when you are creating or making drug you have to ensure that time that your drug is water soluble.

Because if you wanted to interact with blood plasma you have to have one that is going to be easily solubilize which is a lot of the problems with drug is they are not easily solubilize. Now the transport of a lot of material takes place through this liposome. Now you understand that in the center here what can happen? We can have any polar moiety any favorable ionic interaction that might occur within hold the drug in this position and it will transfer to basically where it has to.

It will circulate a blood and then they able to transfer itself. In the case of a Bilayer, what we have is we have the most stable configuration for amphipathic liquids. So this is a possible structure and it is usually used in transport but this sort of a confined structure. If we have a lipid bilayer, then we have the polar groups forming a sheet on one end, the polar group forming a sheet on the other end and we have a lipid bilayer and it is this bilayer that is going to result in all of the transportation.

All of the lipid structure all of the membrane structures that will be seeing in the next class.
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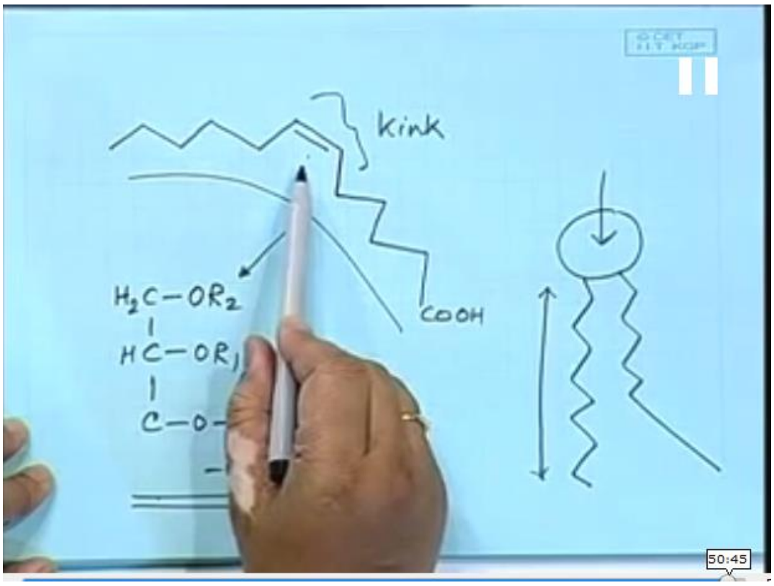

So basically what we learnt is that we have are glycerol, in the glycerol we have storage lipids, what are storage lipids? Storage lipids are those that are fat droplets. What are these fat droplets? The fat droplets are triacylglycerol or triglyceride. What is the basic structure in this case? We have R three carbon glycerol. We have R-OH. We have R-OH. We have R-OH, right? We have this replace by a fatty acid.

This is replaced by fatty acid; this is esterified to fatty acid. So each of these are esterified to fatty acid is going to give our triacylglycerol. What can they be esterified? They can be esterified by a series of fatty acids and we learnt that if we have such a nomenclature delta 5,8,11,14 we know how we can write this, okay. We have normally a long carbon chain where we have the COOH attached in a normal fatty acid.

When we have a nomenclature in the delta designation, we have 18:4, the 18 stands for the number of carbon atoms, the 4 stands for the number of double bonds and these are the position of the double bonds from 5 to 6, 8 to 9, 11 to 12 and 14 to 15. So once we have this fatty acid we can have a cis configuration to the double bond. As soon as we have this in a cis configuration this changes a direction.

As soon as this changes the direction than what happens is I have a, what is called a ‘kink’. So this gives rise to the kink in structure and I am going to have, i.e. in my glycerophospholipid what do I have? I have my H2, I have an R2 here I have an R1 here, I have, what do I have here? I have my phosphate and I have to this linked in X, so this is my polar part.

So what can happen is if this forms R2 and for R1 I have a straight chain carbon fatty acid and this my polar head group, I will have a polar head group that is this part. I will have a long carbon which is this part if I have happened to have no double bond formation and if I have happened to have a double bond formation I will bend it like this, okay. Then what is going to change, what are the properties then of the fatty acids?

I have specific properties of the fatty acids that tell me that the Pk is are around 4.5.5 making them or ionizing them physiological pH and have specific melting points for these depending on what? Depending on the length of the chain and on the number of double bonds that we have there, because the more the number of double bonds what you are doing you are going disrupting the organized structure that it would have.

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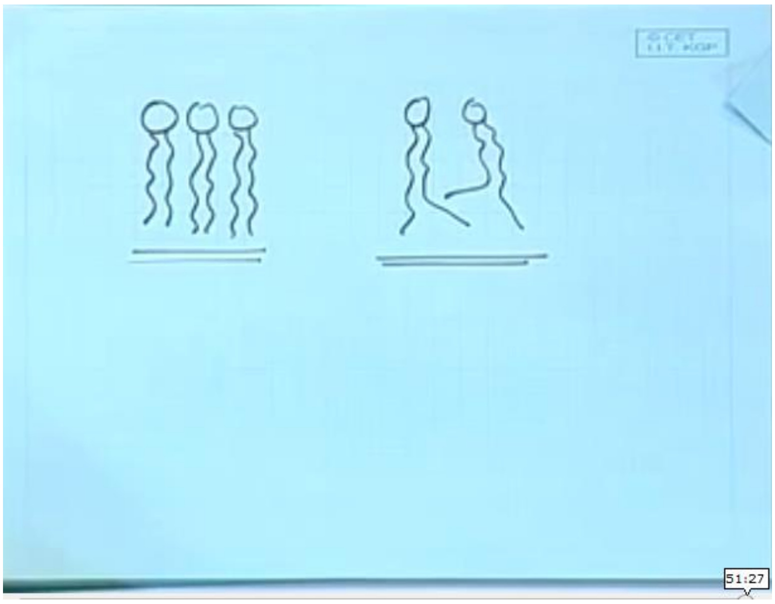

What would happen if would have, it will look perfectly, so this is the way they would be organized, but if you have a kink you would have say one that was shape like that, one that was disrupted like that, so what would happen to this? This would melt easier than this. So the more the number of double bonds the disruption in the structure and you would have lower melting point which is why a saturated fatty acid is solid at room temperature, okay.

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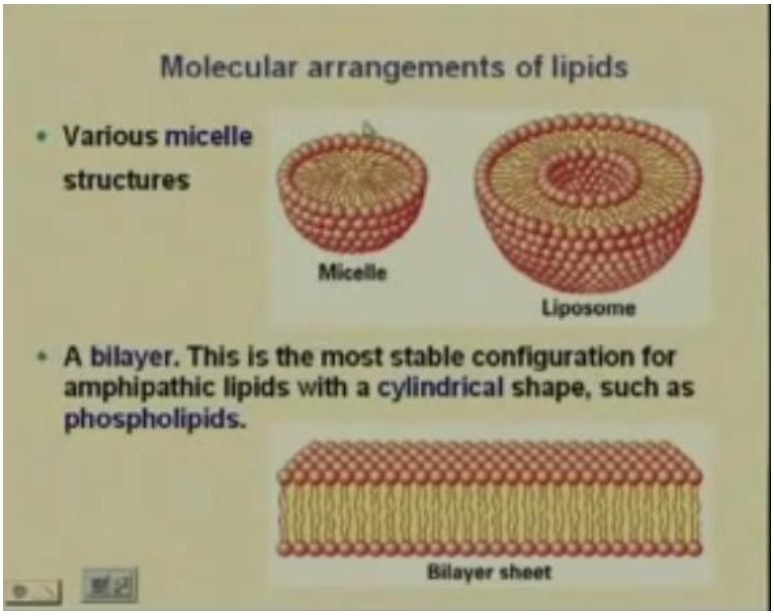

And then we went on to study all the different types of lipids and what we could have, and these are the different types of molecular arrangements of lipids that we can have and then in the next class we will see how we can organize this into an actual lipid bilayer in the protein and we will see how proteins are embed and how they can help in the transfer of material inside and outside the cell. Thank you.