Effective Engineering "Teaching" in Practice
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Lecture – 02b
From Traditional Lecturing to Helping Students Learn (Part – 2)

Welcome back. We are looking at the topic - from traditional lecturing to helping students learn. In the, previous lecture we looked at some aspects of the lecture itself and how it can be a very good tool for learning, at the same time if not done properly it can be disastrous.

And I told you various aspects of the lecture. How to do the lecture well and so on so forth after giving you some demonstration and we saw the advantages of the lecture, we saw the disadvantages of a lecture and the content, what we need to do in the lecture, that every lecture is a performance. How do you improve the performance, other aspects of the lecture and building rapport with the students while lecturing. And then I finally said that story telling is an important aspect of the lecture and that is what we are going to continue with in this particular lecture.

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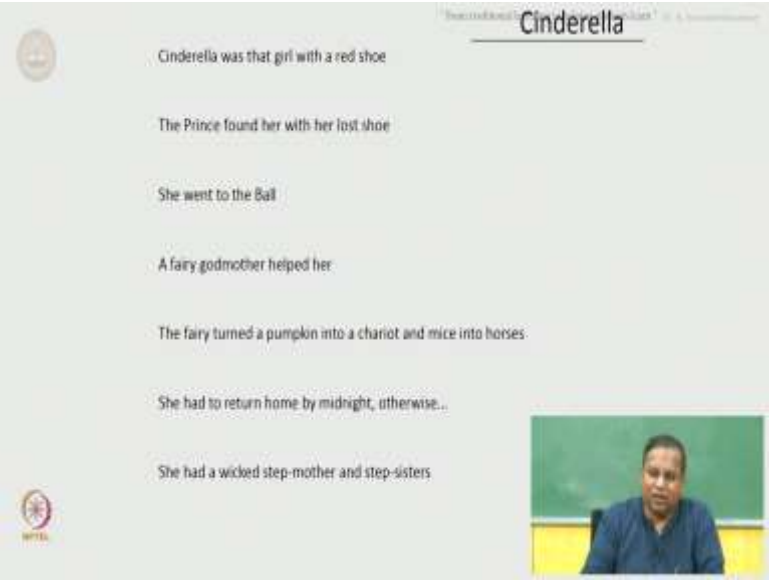

Everything needs to be a story in lecture. Students must be able to understand that easily. Whatever you teach, this might sound a little odd to begin with, but let me demonstrate that to you. Please have some patience. Let us first look at Cinderella. I have actually

done this experiment I have asked students in my M.tech class to write the Cinderella story or to talk about the Cinderella story and this is a typical way in which people narrate the story.

Cinderella was that girl with a red shoe. Red shoe seems to have a huge recall. The prince found her with that shoe, with the lost shoe, she went to the ball, a fairy godmother helped her, the fairy turned a pumpkin into a chariot and mice into horses, she had to return home by midnight otherwise something bad is going to happen, she had a wicked step mother and step sisters, something more and this is the way my students in the M.tech class or at least an average student in the M.tech class many years ago narrated Cinderella.

Imagine you are hearing Cinderella story in this fashion. Would you understand anything? This is a fairy tale right. Children go to sleep when their parents read Cinderella, but still they internalize, understand the story completely all right. But if you tell Cinderella like this, would anybody understand it?

Now compare this with what is done in lectures. This is pretty much the way information is presented in most lectures. I can say that with a good amount of confidence because I have done experiments, have taken samples and so on so forth. There is absolutely no relationship between the various sentences there and that is the way information is present which should not be done; obviously.

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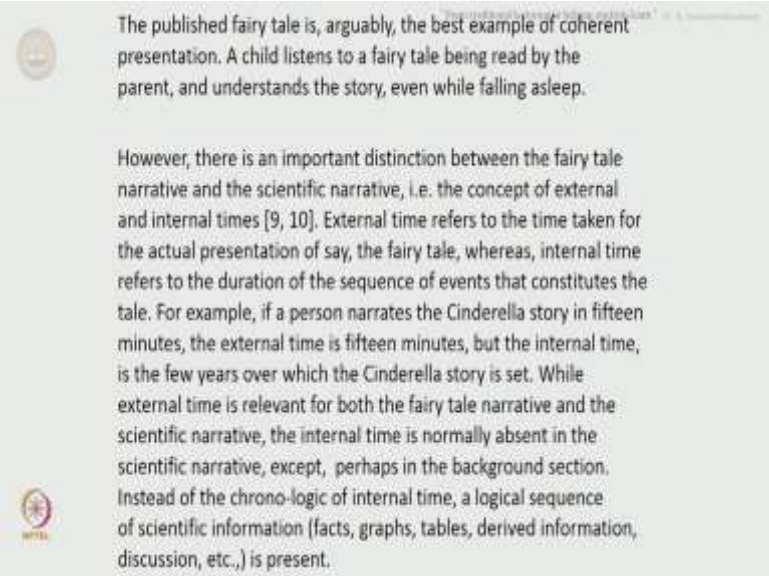

I will readout some parts from one of my earlier papers. A published fairy tale is, arguably, the best example of coherent presentation. Coherent presentation is what we are emphasizing here, presenting it appropriately so that people understand. A child listens to a fairy tale being read by the parent and understands the story, even while falling asleep.

However, there is an important distinction between the fairy tale narrative and the scientific narrative. Scientific narrative is what we all do like teaching papers and so on so forth. That is the concept of external and internal times. External time refers to the time taken for the actual presentation of say a fairy tale whereas; internal time refers to the duration of the sequence of events that constitutes the tale.

For example, if a person narrates the Cinderella's story in 15 minutes, the external time is 15 minutes, but the internal time is the few years over which Cinderella's story is set. While external time is relevant for both the fairy tale narrative and the scientific narrative, the internal time is normally absent in the scientific narrative, except, perhaps in the background section and so on while writing a paper. Instead of the chronologic of internal time, a logical sequence of scientific information such as facts, graphs, tables, derived information, discussion is present when you write papers.

The same thing in a more rudimentary sense needs to be present in the lectures because it is fundamental information. This needs to be present.

Now I am going to give you an example of a story.

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This is in one of the courses that I teach. I would like you to pay attention to the way things are presented, ofcourse the information if you do not know would also be interesting. And I would like you to put yourself in the students place and see how different things are. And it is always good, I have already mentioned this earlier, it is always good to begin at a place where the below average student in class is completely comfortable. That is the place to began.

In this particular thing what I am trying to do is get across the basic biomolecules.

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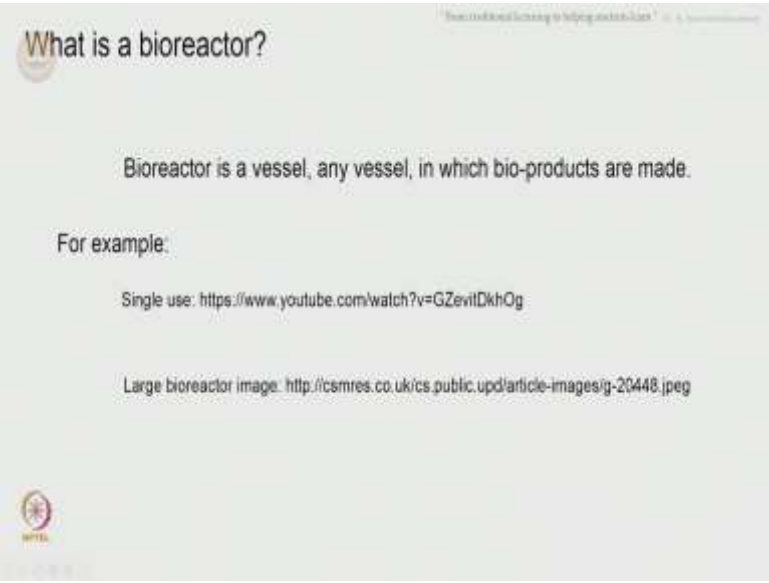

There are four basic biomolecules. I am going to talk about what are called lipids. And I can always say lipids are a class of biomolecules, very important biomolecules, one of the four important classes of biomolecules and lipids are water insoluble compounds that are soluble by organic solvents and so on so forth. It is very dry, it does not provide people or students with enough motivation to either listen to you or even learn that from you. They would probably listen in one ear and let it out through the other. Whereas if the same information is presented in a context with a story and so on so forth it could be that much better.

Let me tell you a very small story very quickly. I am not going to take too much time. I first present what is a bio, in fact I am going to teach to you lipids through the story. Assume that you are students. Now, what is a bioreactor? These are all engineering students. So, they have you know an engineering bent of mind. So, I am giving them a bioreactor, bioreactor is a vessel, any vessel in which bio products are made. You can look at these two pictures in the, on the net. I cannot show them here you can look at those pictures on the net to see what a bioreactor is.

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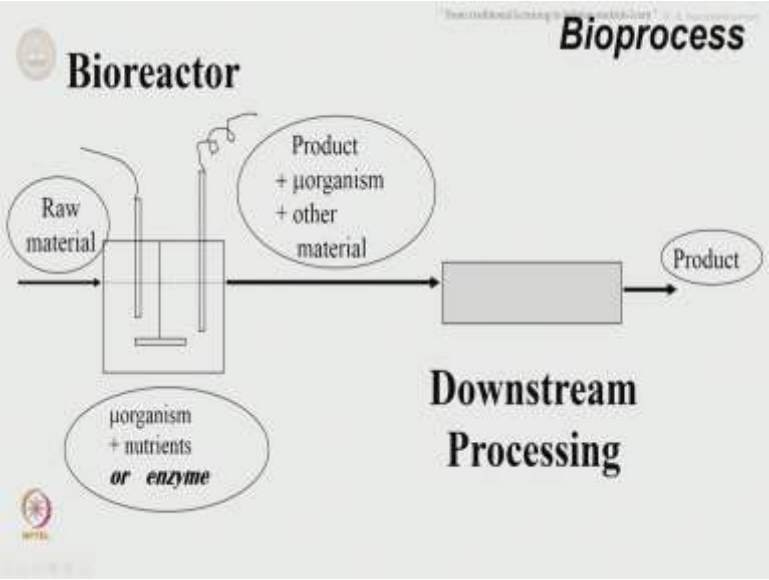

A bioprocess is something that is used to produce biological substances. It has two major aspects - the bioreactor aspects and the downstream processing aspects. Raw material flows into the bioreactor, it gets acted on by the microorganism in the bioreactor or the

enzyme in the bioreactor. Nutrients are provided for the micro organism to grow and what comes out is the product, the microorganism and other materials right.

You are interested only in the product and therefore, you like to separate out or purify the product from all other things and that is what is achieved by the downstream processing steps till a purified product is obtained.

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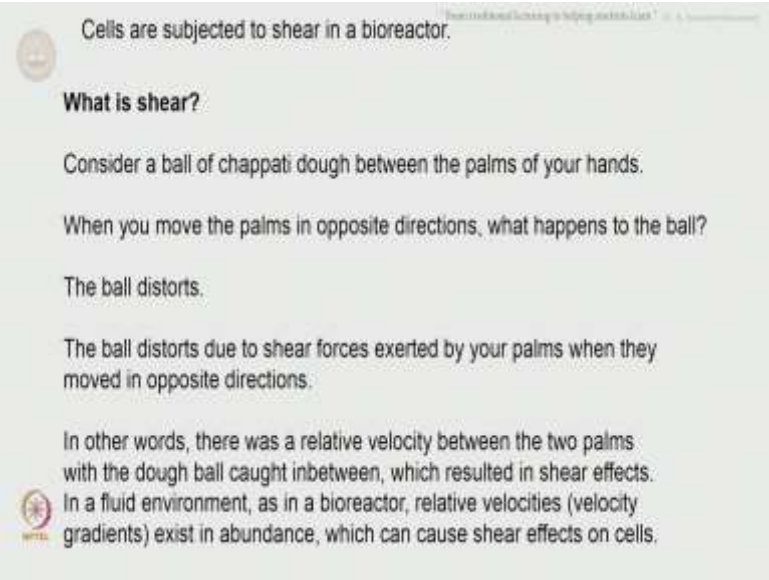

Now cells are subject to shear in a bioreactor. Do you know what shear is? If I talked to first yea,r second year students, they are engineering students- any engineering, they are still to learn much about shear, so they do not know right. So, what is shear? To understand shear let us consider a ball of chappati dough. I am going to rush through this. You know, I know that you are a different audience I will rush through this, but you will get an idea of what I am getting across.

Let us consider a ball of chappati dough between the palms of our hands. When you slightly press it and move them in opposite directions, what happens to the ball? The ball distorts. The ball distorts due to shear forces exerted by the palms, by our palms when moved in opposite directions. In other words, there was a relative velocity between the two palms with the dough ball caught in between which resulted in shear effects. In a fluid environment in a bioreactor, relative velocities such as velocity gradients exist in abundance which can cause shear effects on cell.

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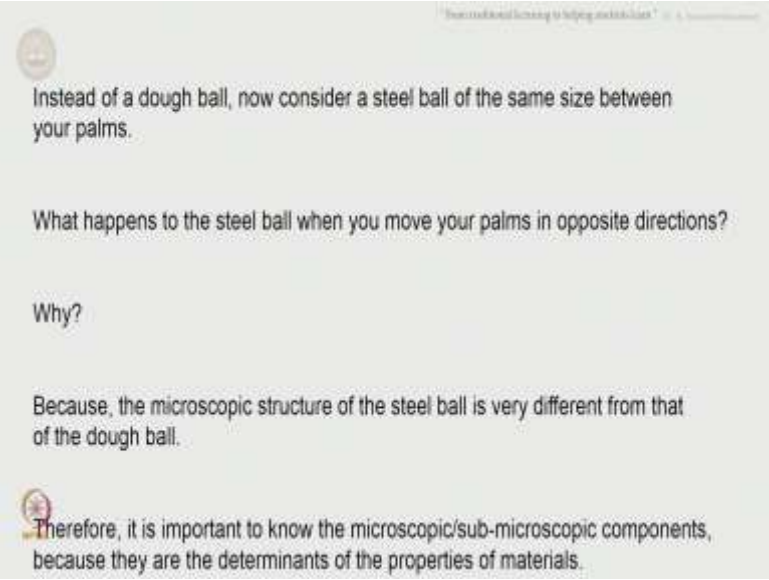

Now, instead of dough ball if you have a steel ball, nothing is going to happen to the steel ball. Why is that? Because the microscopic structure of the steel ball is very different from that of the dough ball. Therefore, it is important to know the microscopic or the submicroscopic components because they are the determinants of the properties of materials.

So, if we have cells in a bioreactor they are going to be subjected to shear. So, what gets affected by shear in the cells that are in the bioreactor? The cells are the ones that produce the product right.

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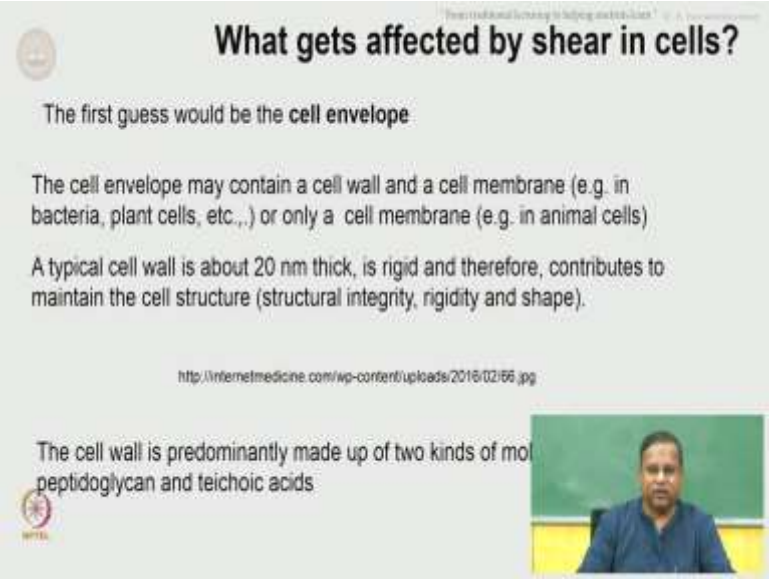

The first guess would be the cell envelope - the one that covers the cell is going to be affected. That would be the first case. And the cell envelope may consist of a cell wall and a cell membrane. Let me skip this, it is going to take too much time, I also talk about the cell wall, cell membrane, do not worry about it.

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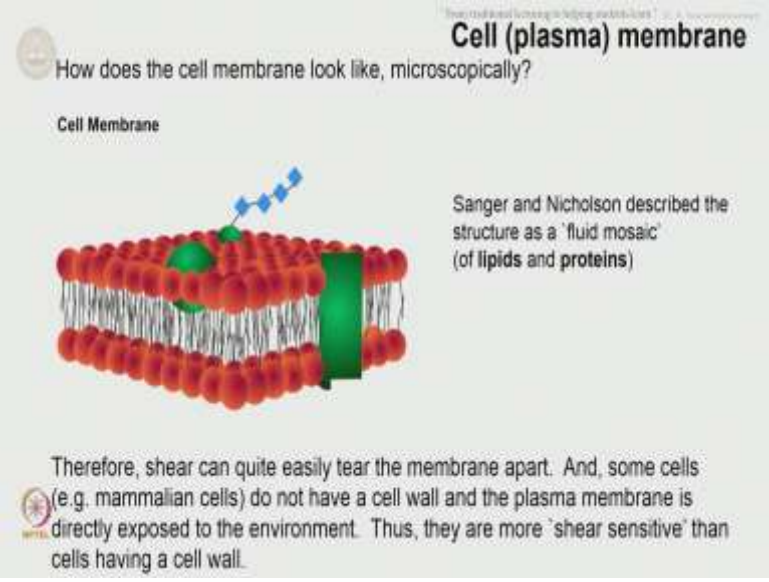

Now a cell wall, we will worry about the cell membrane here. This cell membrane or it is also called the plasma membrane, how does it look like microscopically? That is one of the first things that would get affected. How does it look like microscopically? That is a

picture, it is drawn by one of our own artist, a picture of the cell membrane. You have what are called lipids that are here and proteins embedded. Proteins are the ones in green, lipids are the ones that are shown in red and black. This is the Sanger and Nicholson structure of a membrane, it is called a fluid mosaic membrane. The membrane, the cell membrane is a fluid mosaic mixture of lipids and proteins. That was a structure they put out in the 70s.

Therefore, since it is a fluid mosaic the shear can quite easily tear the membrane apart and when some cells such as mammalian cells do not have a cell wall at all. The plasma membrane is directly exposed to the environment of shear in the bioreactor and therefore, they are more shear sensitive than the cells having a cell wall.

So, we talked about lipids here and proteins. Let us first look at lipids. What are lipids? Let us first look at the formal definition, a very vague definition for lipids, probably the vaguest definition that we will come across in biology. Lipids are water insoluble molecules which are highly soluble in organic solids such as chloroform - that is the definition.

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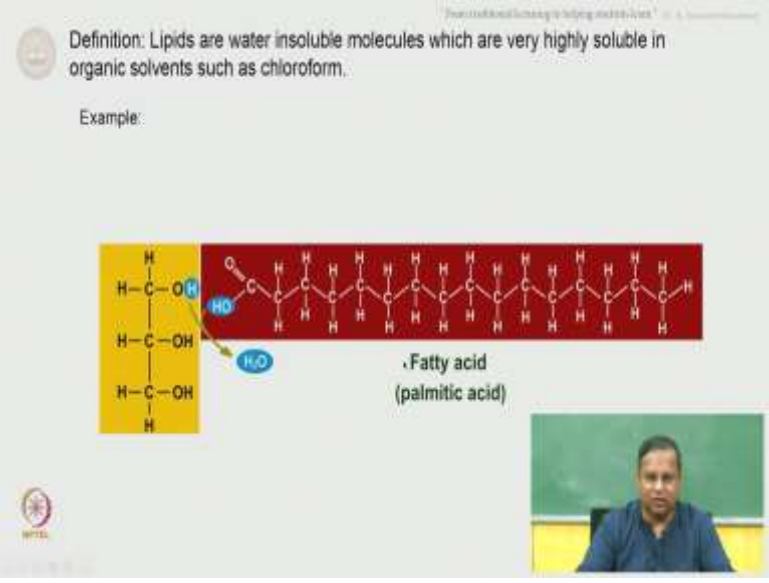

For example, this is a lipid. You have, let us say a glycerol, a three carbon alcohol, multi alcohol backbone here and you attach a fatty acid to this a - long chain carbon atom to this with a acid here, this is an example of a lipid, this has a hydrophobic part and a hydrophilic part here.

If you replace all these three OHs here, this is the glycerol molecule. This oxygen has been attached to this fatty acid here, the palmitic acid with the removal of water. This is what happens - a condensation reaction this comes and attaches itself (Refer Time: 11:48).

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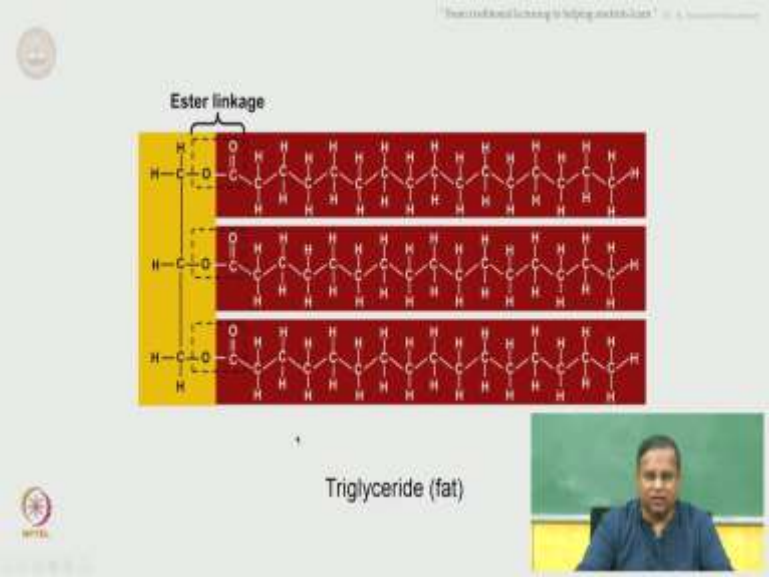

And if you attach all three, then you get what is called your fat - the major culprit in weight aspects and so on so forth. That is nothing but this molecule; if you have three ester linkages here, here and here.

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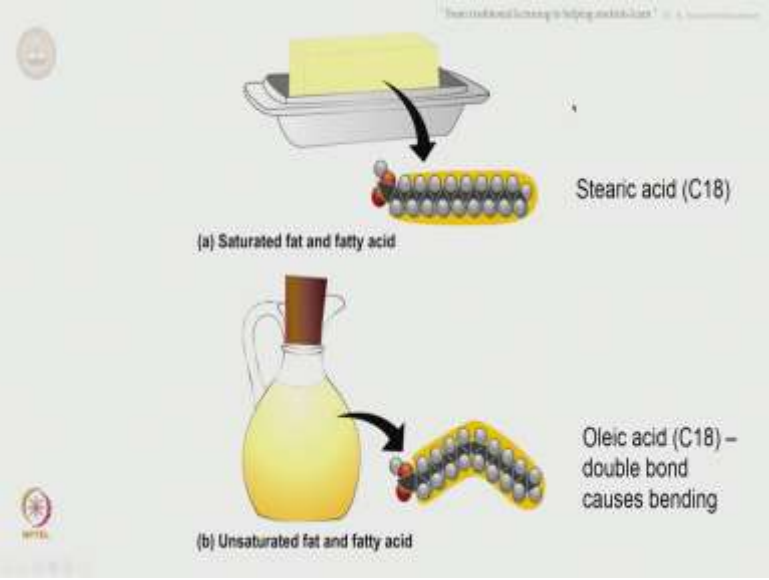

Stearic acid is C 18 long chain fatty acid, is nothing but butter. Oleic acid C 18 with one double bond in between becomes your oil. Oil is nothing, but oleic acid predominantly C 18, 18 carbon atoms with one double bond in between.

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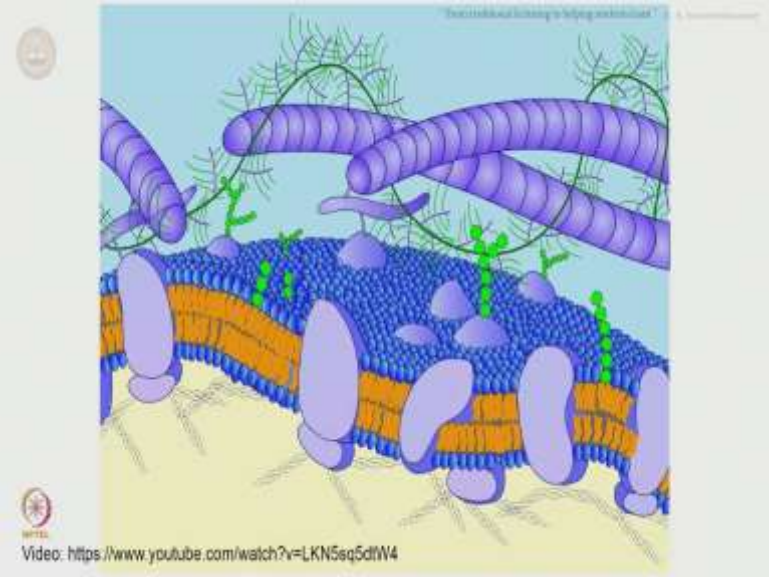

So, the structure of the membrane right, if you look at the fluid mosaic model, you have a lot of lipids here floating around and in a certain fashion floating around and you have proteins here and there are various other things that make up the membrane which we will not get into. You could look at the videos here which explains the structure of the membrane itself.

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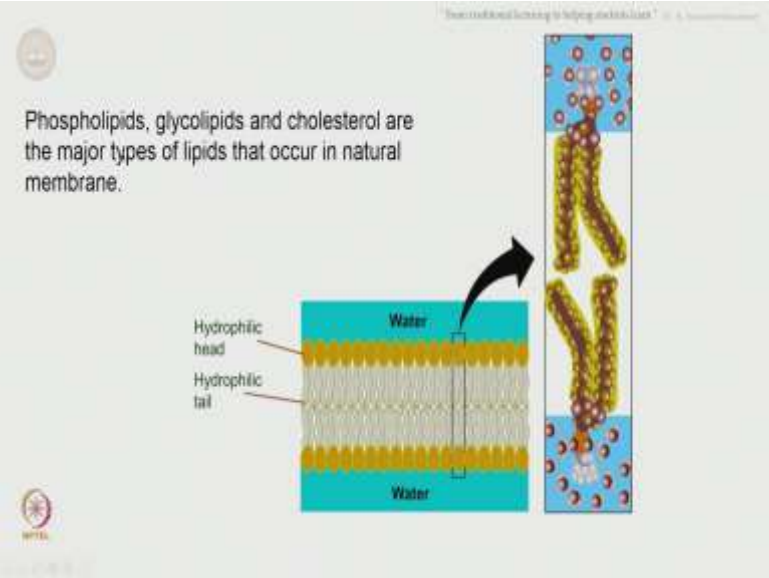

Now, let us look at a two dimensional aspect of the membrane you have lipids here and if you blow up a part of that, it is going to look something like this. This could be the hydrophilic end the hydrophobic tail, you have water on this side - that is a blue here, you have water on this side that is a blue here. You see how the elemental aspect of the membrane is put together. These are the lipids here.

So, these are the ones that comprise a membrane are phospholipids, glycolipids and the cholesterol, you know there is that famous thing which is a villain some time back, that is cholesterol. These are the major type of lipids that occur in a natural membrane.

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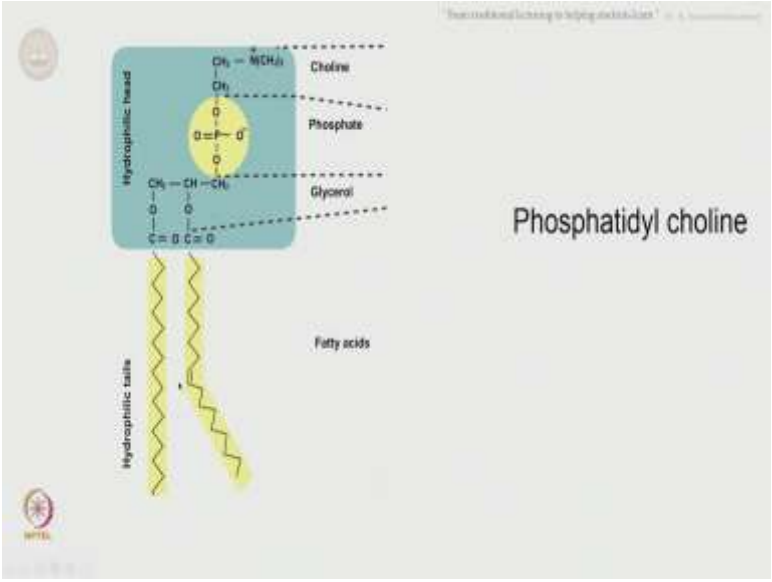

And I go about discussing the structure and so on so forth or at least mentioning the structure.

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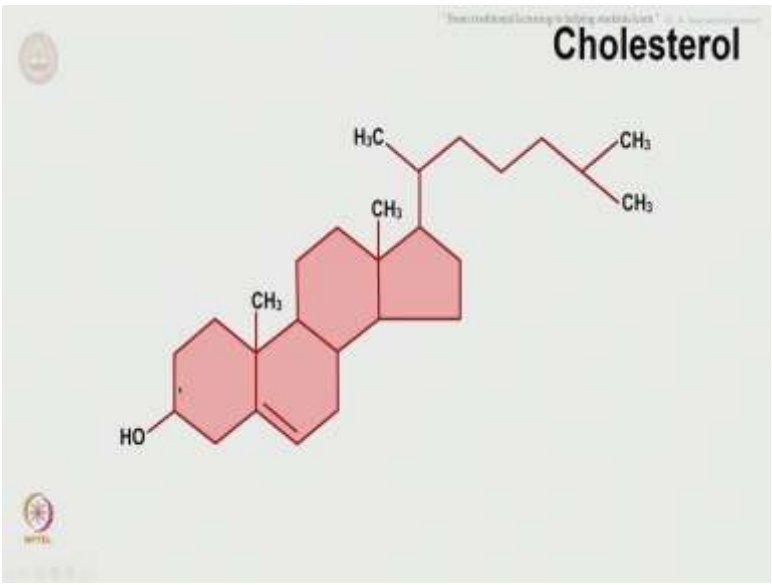

And then come to the membrane characteristics. How do lipids in the membrane determine shear sensitivity? That was the story that we started out in a bioreactor environment.

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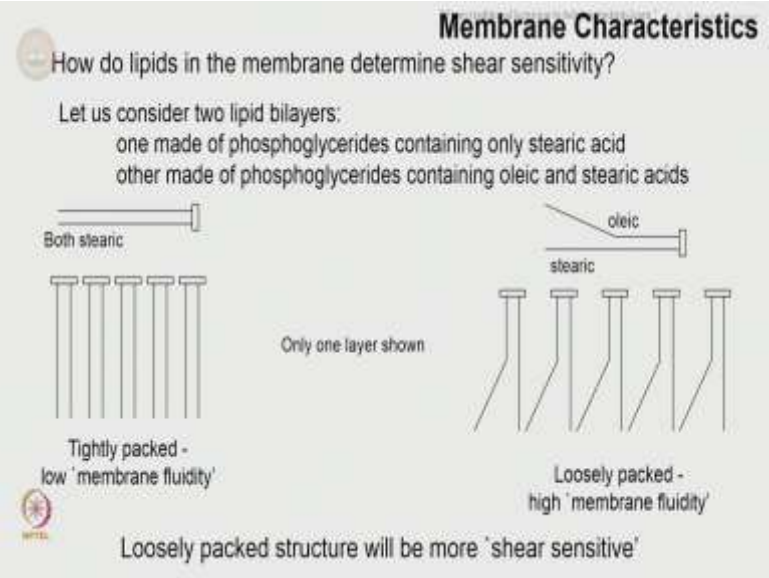

Let us consider two lipid bilayers, one made up of phosphoglycerides containing only stearic acid - a straight chain C 18. The other made up of phosphoglycerides containing oleic and stearic acids. So, both stearic acids would be both straight here with the hydrophilic end here whereas, oleic acid and stearic acid, oleic acid has a double bond here and therefore, a kink and therefore, you have one stearic acid and one oleic acid here. As you can see, this covers a much smaller area compared to this when you pack them together.

So, if you pack lipids containing both stearic acids, it is going to pack tightly. Whereas if you have both the stearic and oleic acid present, it is going to pack loosely because of the fundamental nature of the lipids that are present there. So, this would have high membrane fluidity. It will not be easy for the shear to tear it apart compared to this kind of a membrane which is loosely packed and therefore, has high membrane fluidity and therefore, loosely packed structures will be more shear sensitive.

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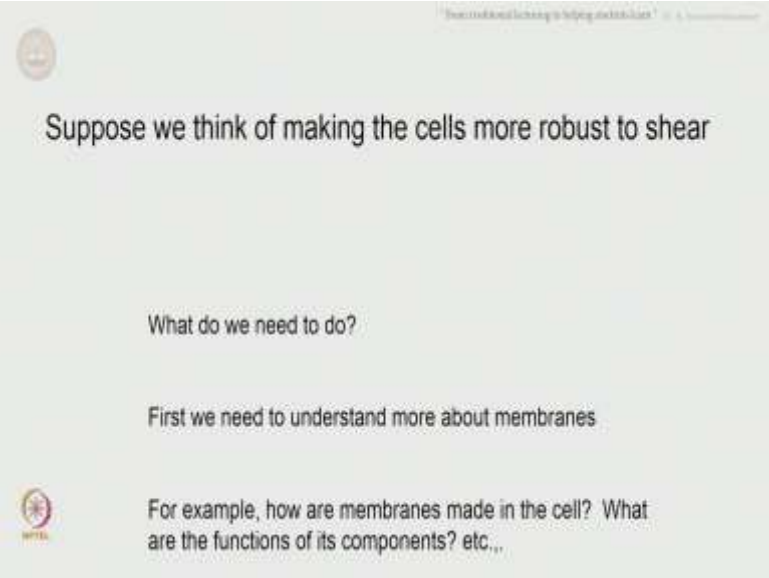

Suppose we think of making the cells more robust to shear, then we need to do various things. We need to understand how lipids are made in the cell, how we can modify the lipids that are made in the cell. So, that the membrane is composed of lipids of a particular kind which should make it less shear sensitive.

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Therefore, I have used a story. I have told them many different aspects while introducing lipids to a class of uninterested or you know completely uninterested engineers. And when you tell them in the form of the story, they get a context, they get the significance

and therefore, they would have understood one of the very fundamental aspects that lipid is a basic bio molecule, that it is one of the four different types of bio molecules that make up the cell and so on and so forth ok.

The next question is many engineering courses are math intensive. Mathematics, a lot of mathematics. Can storytelling be used in math intensive courses. The answer is yes, a very emphatic yes and in fact, we have already done that in some of the earlier things that we have done. You can go back and check. If you want better, clarity just wait through the course see where I am converting or I am presenting mathematical aspects in the form of story.

A story is something that engages the student. That is all I mean by the story. And therefore, a lecture in its complete sense; not just I talk you listen, can be considered as a very good base tool to facilitate learning. That itself is not enough. We need to go much further because not everybody is a highly talented lecturer. We will see how to take things forward in the upcoming lectures. I think that is all I have for this particular lecture. When we meet next, we will take things forward. See you.