Dairy and Food Process & Products Technology
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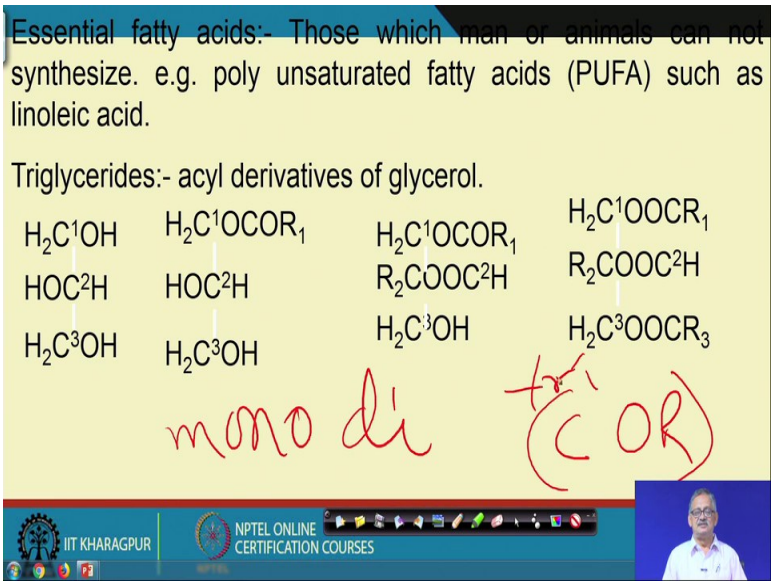
Lecture - 22
Milk Fat (Contd.)

So, we were discussing about that Milk Fat and while doing that, we said we will also try to give some chemistry of the fat. Otherwise, it may be difficult to understand right. So, we came up to saturated fatty acid saturated, right. Now, if we this was our last class, now from the saturation if we go to unsaturation, here of course, some of the things have gone beyond.



So, essential fatty acids are those which man or animals cannot synthesize, for example, poly unsaturated fatty acids or PUFA, such as linoleic acid.

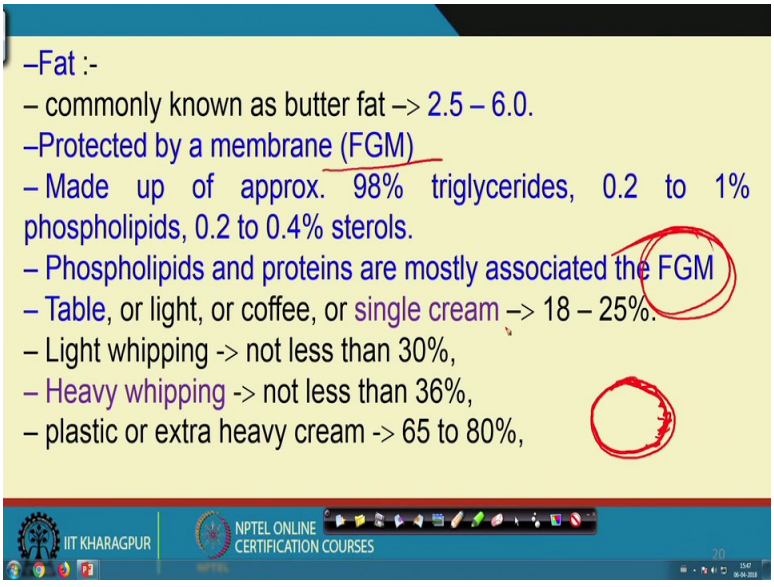
In earlier class, we have seen that depending on oleic acid, depending on linoleic acid, there the number of unsaturations are 1 or 2 or somewhere it was 3. So, linolenic acid is one such where it is double bond, 2 doubles ones and we call it to be polyunsaturated fatty acids or PUFA. This I said in the last class also that people do capitalize their advertisement on that because, this unsaturated fatty acid the human being or animals they are not able to synthesized in their body system. So, that is why they are called essential, why essential? Because they are not being synthesized by the body; so, that has to be supplemented externally, right.

And that is the keyword which the oil producers different, they do capitalize the advertising that they have polyunsaturated fatty acid in their oil, whatever be the vegetable oil or whatever be the other oil, right. And you if you remember we said that this olive oil oleic acid which is also a unsaturated fatty acid, that do contain around 70 80 percent in the olive, right.

Whereas, saw flower that contains around 60 to 80 percent depending on, again depending on what is the source of saw flower where from it is coming, where it is grown up, how the processing is done, all factors come into and it varies between 60 to 80 percent of the unsaturated fatty acid available, right.

Linolenic acid they are, but we call polyunsaturated PUFA linolenic, where it is more than one unsaturation is there, right. So, normally these are acyl derivatives of glycerol, right. Where this is the glycerol this has this double bonds, right not double bonds. So, this cell groups, right. This is mono, this is di and this is tri, right. Are you remember I said the cell group to be that COR, sorry COR, right. This was C COR, right. This is the unsaturation, this is called the acyl group, and this R can be anything, right

So, there this acyl derivative of the glycerol, that is either monglyride or diglyceride or triglyceride, this can be said to be mono, this can be said di and this is triglyceride, right. So, with this basis let us now proceed to a the milk fat, right. So, if we look into that milk fat, it is commonly known as butter fat, milk fat is commonly known as butter fat.



And generally, it is varying between say 2.5 to 6 percent, could be lower, could be higher depending on the source again, depending on the source, depending on the species etcetera, this may vary.

But for simplicity to have the idea to make it general, we call it around 3 to 6 percent, right. 2.5 is also a odd number, 3 to 6 percent generally we call that fat content in milk, right. Because cow milk contains less, buffalo milk contains more, that we have seen in the earlier class, right. And so, 3 to 6 percent is the commonly milk contents fat.

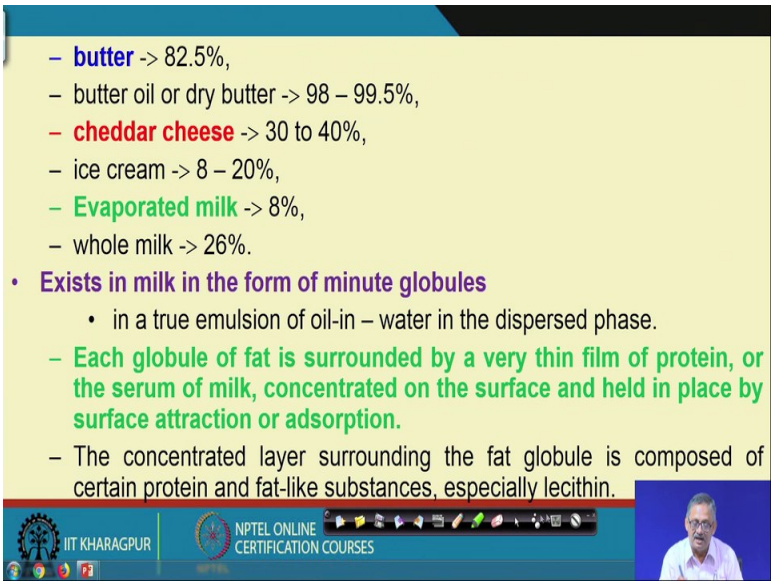
Now, these fat molecules are this fat of course, they are not said molecules, they are said globules because, they are like this. So, this is a fat globule, right and in this globule, there is a fat globule membrane. So, this membrane is there and that is called FGM or fat globule membrane. So, it is made of approximately 98 percent triglyceride, 0.2 percent to 1 percent phospholipids and 0.2 to 0.4 percent sterols.

Phospholipids and proteins are mostly associated with the FGM; that is, the that is the milk this is fat globule membrane. So, this fat globule membrane contents phospholipids and proteins mainly. And in milk fat it is around 98 percent triglyceride 0.2 to 1 percent phospholipids, and 0.2 to 0.4 percents sterols in the milk fat, right.

Now, if we get around 18 to 25 percent fat so, that fat is called single cream or coffee cream or light cream or table cream so, any name that can be between 18 to 25 percent. So, not less than 30 percent they are called light whipping. So, whipping I remember that it is coming to my mind, now that I had said it that whipping means when you are incorporating air, right. Like when you are doing omelette and other things with egg, that time you do stir it, and during the stirring what you are doing? You are incorporating air into it that is why it is becoming fluffy.

Otherwise omelette just like that you try one day, without fluffy without doing that we just put it. And do that with omelette or whatever we call that if you make their the thickness will be very, very less, whereas, if you do the stirring you will see that it has become a little more fluffy. The same quantity, but it appears to be more so, that is why it is more lucrative and more may not be by nutritive value you are changing anything, but the esthetic value of the food you are changing.

So, that is where the this your are this thing is whipping is very much required right. So, in that sense, if it is less than 30 percent, then it is called light whipping, if it is more than not less than 36 percent, then it is called heavy whipping, and if it is more than 60 to 80 percent, then that is called plastic or extra heavy cream, right.

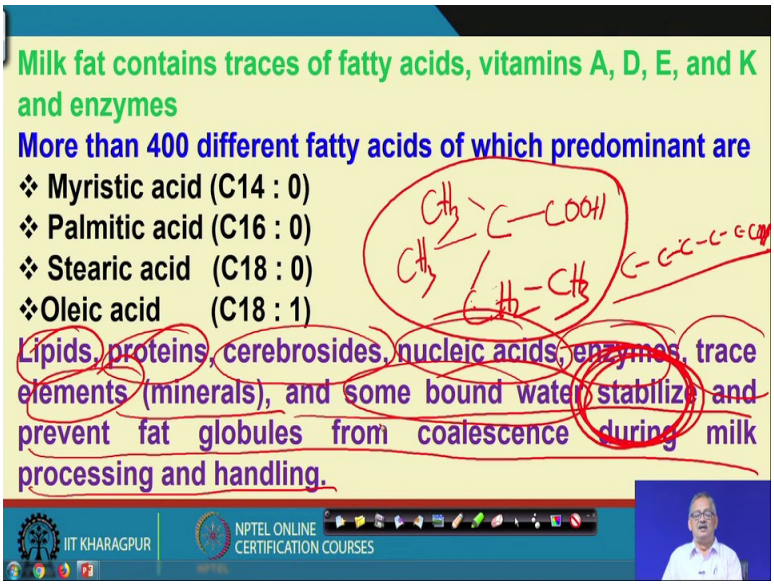


Similarly, butter contains around 82.5 percent plus minus 82.5 percent cream, and butter oil contains not less than 98 to 99.5 percent fat. Cheddar cheese contains around 30 to 40 percent fat, ice cream around 8 to 20 percent, evaporated milk not less than 8 percent, and whole milk contains 26 percent.

Now, all this exist in milk in the form of minute globules, right. Just in the previous slide I have shown, minute globule. So, in a true this is a true emulsion of oil in water, O W, oil in water true emulsion; where the emulsion means there is a continuous phase and there is dispersed phase. The continuous phase is one which is more in quantity; that is, continuous phase, in this case water is the more quantity more quantity wise component, and in that the oil or fat is there that is way it is called oil in water. Similarly, in butter it is the reverse where is more component is the fat that is 80 to 83 percent, less quantity is water.

So, that is called that is called water in oil, right. One is O W and another is W O emulsion, ok. Each globule of fat is surrounded by a very thin film of protein or the serum of milk, that is concentrated on the surface and held in place by surface attracting or some absorption material. By either surface attracting material or by absorption, if this

is there; The concentrated layer surrounded the fat globule is composed of certain protein and fat like substances, especially, that is called lecithin, and the other day I said about lecithin the story of the saas bahu I said now I remember hopefully here we are finished up ok.



So, milk fat that contains traces of fatty acids, some vitamins like A D E K, and some enzymes, right. More than 400 different fatty acids of which predominance are, there are more than 400 fatty acids, right. Now as we have seen fatty acids can be of anything which are bigger carbon right. So, more than 400; obviously, in your mind it may come, sir I said long chain fatty acid short chain fatty acids there is a true, 2 to 80 carbon number of carbons, right are you said their naturally occurring.

But predominantly between 2 to 20, beyond 20 or 24 it is in the family of waxes. In the lipid family it maybe even higher right. So, 400 different fatty acids are there, now this fatty acid suppose one fatty acid is like this. You see, this is one carbon, this is and the 2 hands, this is the third hand, right and this is the forth hand. So, if this is with one carboxylic acid, right. If this is with one methyl group, this is one methyl group, this is one methyl group, then that can be how many? 1, 2, 3, 4, 5, right; Or if it is CH instead of CH 3 if it is instead of CH 3 this is the eraser.

So, if we make it like this that if it is CH 2 CH 3, right. This group you put so that 1, 2, 3, 4, 5, 6, 6 membered right. So, after that butyric we have said that was to my memory it is

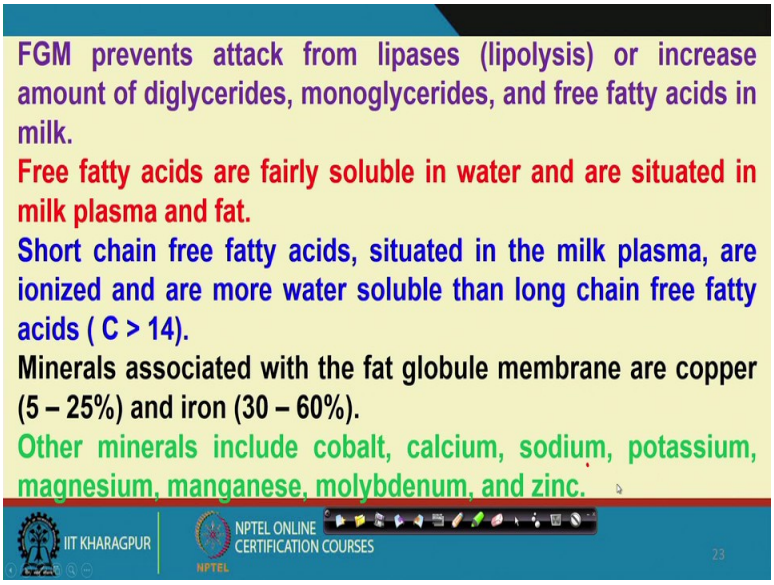
either capric capric acid to my memory right. So, there either capric caprylic hopefully capric acid. So, there it is C 6, but that was straight chain1 2 3 4 5 and then COOH, right.

So, these was straight, but here it can be like this. So, how the stereo chemically they are? So, depending on that different fatty acids though same number, different fatty acids could be there, that is why though we said C 2 to C80 so, automatically it come. So, there should not be more than 70, 80 numbers of fatty acids, but it is not so. This is in a in numerable.

So, that's why you are saying that more than 400 different fatty acids are predominantly in milk fat, out of which are in milk fat out of which predominance are myristic acid which is C 4, with 0 that is no double bond. Palmitic acid with C 16 with no double bound; Stearic acid with C 18 no double bond, and oleic acid with C 18 with single double bond, right. So, around 400 different fatty acids are there in milk, right. Predominance are C 14, 16, 18 with single or no double or saturated, right they are predominant, ok.

Then lipids, proteins, cerebrosides, nucleic acids, enzyme, trace elements, minerals, trace elements like minerals some bound water stabilize and prevent fat globule from coalescence during milk processing and handling. So, all these factors like presence of lipids presence of proteins than the cerebroside, nucleic acid enzyme, trace quantity of minerals or elements some bound water, these stabilize that is the primary, these stabilized and prevent milk fat globules to coalescence. Coalescence means coming together and burning.

Now, I remember I said that the thermometer breaking and getting that mercury droplets or globules, and when they are coming together, they are they are agglomerating. So, this is also a kind of agglomeration of the fat globules. And these prevents those fat globules to come and close come close and form the bigger molecule right. So now, let us go perhaps we had we are said.



Now, FGM this prevents attack from the lipase of subsequently when we will go to other constituents of milk, there will see that there are n number of enzymes present in milk. N number of enzymes are present in milk, right.

In many occasions I am saying that in our saliva, the it also contains lot many numbers of enzymes, that to it activates it comes when you are chewing, that is why you are asked you are said that do not grab the food, you chew and the during this chewing that saliva secretion is in secreting enzymes, right. So, milk contains naturally many numbers of enzymes, one such enzyme is lipase. Now, lipases is one and any enzyme by this time hopefully you know, as I am saying that has when things are coming I am trying to explain a little more. So, enzyme their name as a s e, any enzyme is ending with a s e right?

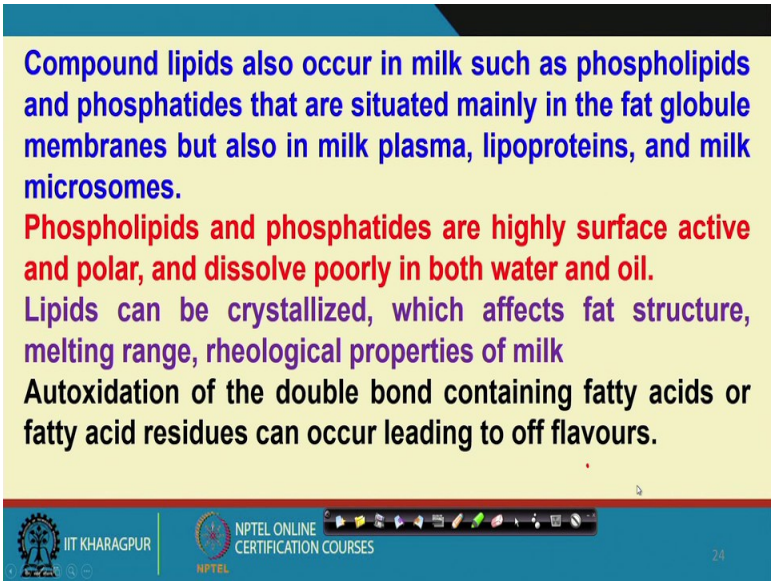
So, like lipase, lipase right so, would lipase means the enzyme which is acting on the lipid, right. Lipid was the bigger umbrella in which fat is also there. So, enzymes which act on lipids are called lipase, right. So, this fat global membranes, they do protect the fat from the action of the lipase. Otherwise, otherwise these fat molecules since lipase enzyme is there it will see it's food is their, food is that fat so, fat is there. So, go it goes and breaks, that is what it is it is work.

So, wherever free fats are like that available, then go and break it, that's the lipase enzymes activity. But it is not able to because, the globule is already protected by the fat global membrane, which is we have said that some protein some lipoproteins and some

enzymes are also there, right. So, free fatty acids are fairly soluble in water, and are situated in milk plasma, and fat free fatty acids are fairly soluble in water, and are situated in milk plasma and fat, right.

Short chain fatty acids situated in the milk plasma are ionized and are more water soluble than long chain free fatty acids, where this long chain is more than carbon number 14, right; If this long chains are more than carbon number 14's. Minerals associated with the fat globule membrane are copper, generally between 5 to 25 percent, iron between 30 to 60 percent. Other minerals include cobalt, calcium, sodium, potassium, magnesium, manganese, molybdenum and zinc, they are also present.

We will come more in detail about when we are talking about the minerals content in milk, right.

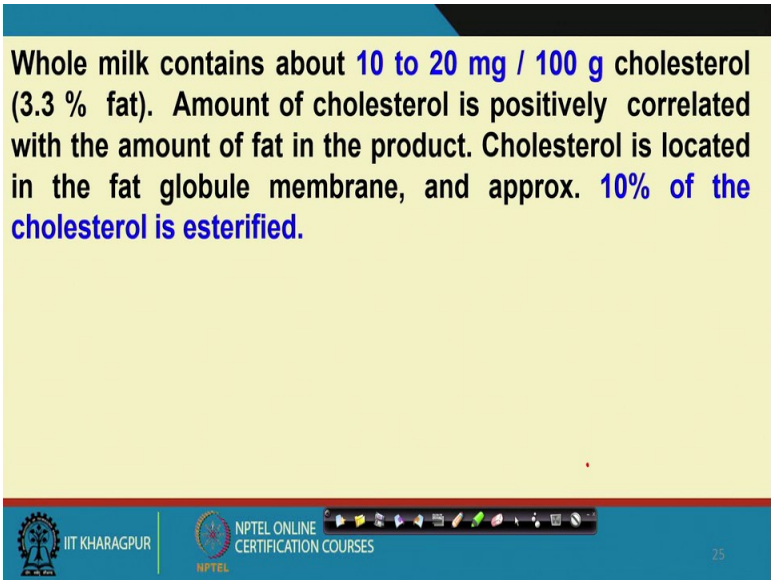


Now, compound lipids also occurred in milk such as phospholipids and phosphatides, right. Phospholipids or phosphatides, that are situated mainly in the fat globule membranes, but also in milk plasma lipoproteins and milk micro microsomes it is present. Phospholipids and phosphatides are highly surface active and polar and dissolve poorly in both water and oil, right.

Lipids can be crystallized which affects fat structure melting range rheological properties of milk, right. So, these lipids can be crystallized which affects that lipid content in milk that affects, the fat structure of the fat melting point of the fat, or melting range of the fat, then rheological properties of the fat.

Obviously rheological property how in which the viscosity comes primarily in into the picture, right; Autoxidation, that is autoxidation where it is oxidation by itself of the double bond containing fatty acids or fatty acid residues can occur leading to off flavours. Now, if there are lipids present in milk, not if milk contains lot of lipids. So, this lipids may undergo auto oxidation, and of course, this oxidation will come subsequently in more in detail, right.

So, there this autoxidation may produce off flavour in the milk, which is of course, not desirable, right. Then we come to this that whole milk contains about 10 to 20 milligram per 100-gram milk cholesterol.



So, 10 to 20 milligram cholesterol per 100 gram of milk, that is around and where milk is around 3-point 3 percent, right. Fat amount of cholesterol is positively correlated with the amount of fat present in the product or in this case milk, right.

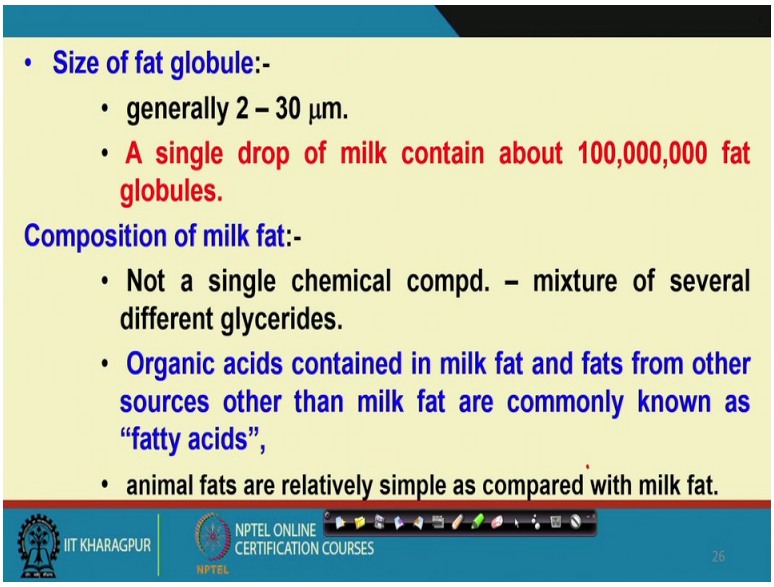
Obviously if the fat content is low, then the cholesterol content also will be low, if the fat content is high, the cholesterol content also will be high, that is why it is said 10 to 20 milligram, though the number is 10 and 20 not so big, but in milligram per 100 gram of milk so, that is not very very small, right. If you convert it in terms of ppm it will also be a good in number right so, ppm means parts per million right. So, gram and milligram is 10 to the power 3. So, when it comes to 10 to the power 6, then it comes to ppm, right.

So, this you convert and see, that it is several 100's or 1000's of ppm that 10 to 20 milligram, right. And cholesterol is located in the globule membrane and approximately

10 percent of the cholesterol is esterified. Approximately 10 percent of the cholesterol is esterified, right. Because cholesterol so, with O L, I ending with O L anything O L ending with O L normally is hydroxyl having hydroxylic group, right. Hydroxyl group is associated with the naming of that ending with O L.

So, cholesterol is such; that means, there is also hydroxyl group present, the moment hydroxyl group is there. So, there are fatty acids so, this free fatty acids will come and join with the cholesterol, they are by binding them in and the form of ester, right. That's what it is sin that around 10 percent of the cholesterol is esterified, and this cholesterol are located in the globular membrane, that outside putting of the fat globule in that fat globule outside membrane is the cholesterol present. And that is generally 10 percent is esterified.

Now, size of the fat global, it varies between 2 to 30 microns, we said earlier also.



So, the lower the size, more is the number, the higher is the size, less is the number, right. Because biggest size will have less in number, smaller size will have much more in number, right. And in one class we said, that this fat globules can be seen also in the microscope that they with glycerol as the medium, then they will be this globules will be dancing, right.

And please tell me that this by which law this can be said, right. This is the free movement of the fat globules. I gave this as the hint, single drop of milk contains about 10 to the power 8, right. 100, 000, 000; So, 10 to the power 8 number of fat globules are

single drop, single drop and one drop is how much? One drop normally we say a drop which comes out from pipette or burette, that drop is around 0.05 m l; So, 0.05 m l, these contents 10 to the power 8 number of fat globules.

Now, imagine that 1 litre, half litre how many numbers of fat globules will be there, right. And that is why more and more we are saying about the stability of the fat, that one it is stabilized by that lecithin as a emulsion, then the fat global membrane; that is, where cholesterol is also playing an active role as it is also part which is forming in the membrane. And this 10 percent of the cholesterol is also getting esterified with the free fatty acids, right.

So, with this our time is over now. Let us come and next again will continue with the composition of the milk fat. So, many things are there to know, so many and we will we will definitely we will definitely cover as much as possible a both in terms of chemistry as well as the physics of the entire thing. Because this is the one which we need to understand; And ones we are then any kind of processing, we will be much better off than corresponding may be mechanical or chemical people, who may not be doing inside of it so much, right.

Thank you.