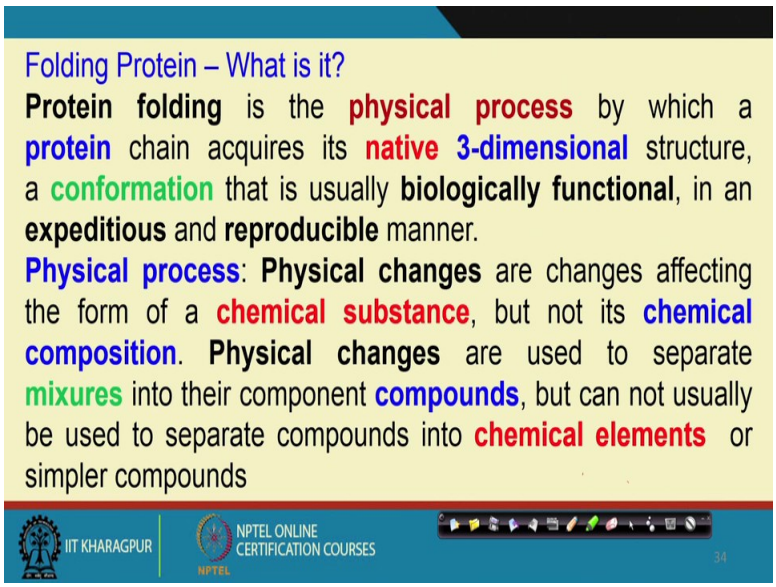
Dairy and Food Process & Products Technology
Prof. Tridib Kumar Goswami
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur

Lecture - 26
Protein (Contd.)

So, we are discussing about the basics of protein, right. So, in this Dairy and Food Products Food Process and Products Technology in lecture number 26; we still say about the basic of the protein. We you if you recall that we landed up to some terminologies which we said that we will need to explain. So, let us look into that.



So, we said that folding then what it is? Folding is protein folding is the physical process by which a protein chain acquires it's native 3-dimensional structure a confirmation that is usually biologically functional, in an expeditious and reproducible manner. This we have said, that folding is what explained also. Now, it comes that what is that physical process.

The physical process is that that physical changes are changes affecting the form of a chemical substance, but not it's chemical composition, right. So, it is affecting the form of the chemical substance; not the chemical composition like we know simple one I am telling that fructose or glucose, we know the chemical formula is C 6 H 12 O 6, right. Why I am giving is that because this is simple, but when we are going to any complicated things like a protein who made of amino acids they are big in terms of

structure, in terms of formulae etcetera. So, to understand this that say C 6 H 12 O O 6, right. So, this combination can be of different ok, but the change is which are being this physical process where it is being happening it is the only physical system change it is happening, right.

If you have come across that that ok I give another that C dot C 6 H 12 O 6 even much more simpler that is C 6 H 6 that is the benzene, right. C 6 H 6 that is the benzene right, benzene can be the straight chain, right C 6 H 6 and it can also be a ring chain, right.

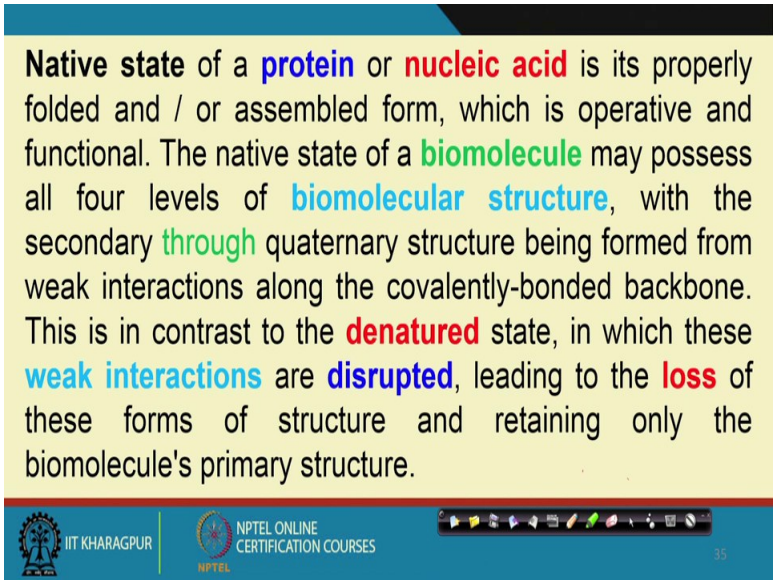
So, and also it can like the one which we have just said about that glucose C 6 H 12 O 6 it also can have a straight chain it can also have a ring chain structure or it can also have a chair form structure, right. So, but all of them are the physical orientation of this right. So, there is no chemical change in that it still remain C 6 H 12 O 6 or C 6 H 6 and there their chemical properties did not change.

So, physical process means where the physical changes are being brought about and there is no chemical compositional change is happening. So, physical changes are used to separate mixtures into their component compounds like physical separation in our school age we you have done that you were given a mixture of sand and mix and may be some iron and some others so, how can you separate?

So, that is the physical separation system. So, you took some may be magnet to count the irons and then you separate it iron and this thing sand. So, that is a physical system physical change, right. No chemical it neither the iron was chemically changed nor the sand was chemically changed.

So, this is what is the physical process meaning right, but cannot, but cannot usually be used to separate compounds into chemical elements or simpler compounds. So, we have not brought down C 6 H 12 O 6 to carbon dioxide and energy and water which normally we do in our respiration our respiration the basic unit is that C 6 H 12 O 6 that is the glucose from where we are getting energy and this is getting chemically converted into carbon dioxide water and energy. So, that is the chemical change no longer physical, right.

So, physical changes are those where no chemical changes, but there may be some formation or separation of the components in from the mixture.



Then we said native, right. So, this native word where I am again saying it is rather, this might have come across during the British era that they use to tell the Indians to be native know. So, that native of course, is a connotation of days, but the meaning of the our native protein is that the native state of protein or nucleic acid is it's properly folded and or assembled form folded both folded or assembled form which is operative and functional.

The native state of a bio molecule may possess all four levels of bio molecular structure with the secondary through quaternary structure being formed from weak interactions along the covalently bonded backbone this is in contrast to the denatured state. Another thing which you might have come across that is called denaturation of protein, right.

So, this is native state is that the protein on nucleic acid in it is properly folded or assembled form which is operative and functional. The native the native state of a bio molecule may possess all four levels of bio molecular structure. Four molecules means four structure means primarily it is primary structure, secondary structure, tertiary structure and quaternary structure.

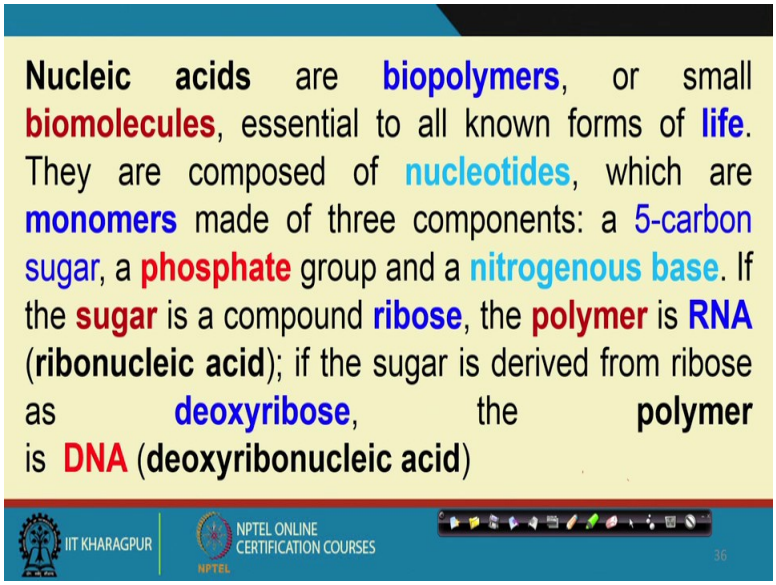
So, all this four could be there that is what it is called the native state, right and with the secondary through quaternary structure being formed from weak interactions along the covalently bonded backbone.

So, there are some backbones covalently bonded so, that can be interchanged. So, that kind of that is possible right the exists called the native protein that whatever it was. So,

the structure in terms of secondary, tertiary or quaternary for may be interchangeable and in that case this is called the native protein, right.

But, unlike the other one which is called denatured protein denatures protein is that in which these weak interactions amongst the secondary to tertiary or quaternary state or quaternary form are disrupted.

So, they are no longer they can be converted or they can be interchangeable to secondary to quaternary form, right that is called denaturation where this weak linking or weak interactions between the bondings, covalently bondings they are not possible leading to the loss of these forms of structure and retaining only the bio molecules primary structure, right. So, if they are leading to the primary structure then that is called denaturation or denatured protein, right.



Then, it comes that nick that we earlier said that protein or nucleic acid, right. So, then it comes to nucleic acid what is that? Nucleic acids are biopolymers of small bio molecules essential to all known forms of life. Essential to all known forms of life nucleic acid is the biopolymer or small bio molecules which are essential to form life. They are composed of nucleotides. Another term which we have brought in nucleotides nucleic acid from there nucleotide, that is the bio nucleic acid is the biopolymer or small bio molecules.

They are essential to form the life and in that they are composed of the nucleotides which are monomers made of three components like a 5-carbon sugar; a 5-carbon sugar that is

called ribose, a 5-carbon sugar a phosphate group and a nitrogenous base. All these three put together is forming the nucleotide. What is that? 5-carbon ribose a phosphate group and a nitrogenous base.

Now, if the sugar is a compound of ribose the polymer is called RNA or ribonucleic acid, right and the if the sugar is a derivative or derived from ribose if it is a derivative of ribose or derived from ribose then it is called deoxyribose or the polymer is known as DNA or deoxyribonucleic acid, right deoxyribonucleic acid or DNA.

So, that means, basically both are it is having a sugar unit that is 5 members sugar ribose and it is also having a nitrogenous component as well as it is having a phosphate component. All these three put together is forming the nucleotide and this nucleotide if it is made of ribose then that is called ribonucleic acid or if it is made of derivative of ribose that is derived from ribose that is called deoxyribose then that form is called DNA and the polymer is known as deoxyribonucleic acid, right.

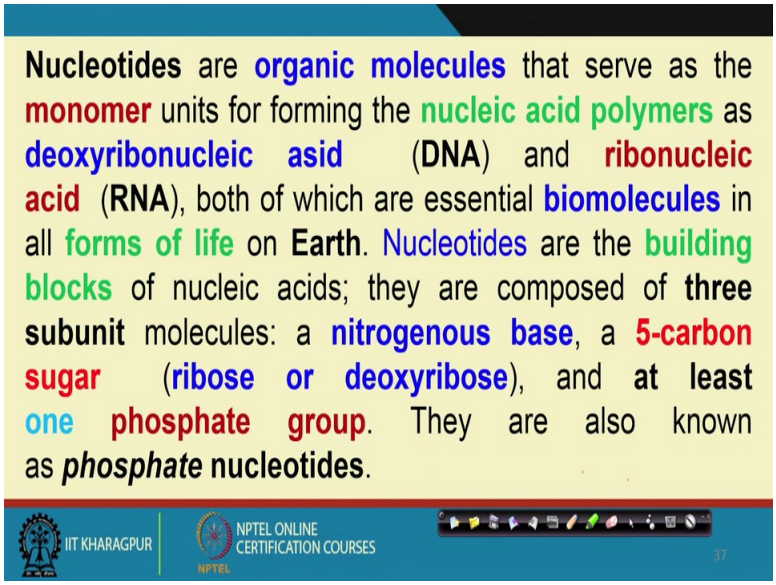
Then we come to nucleotides again nucleotides are organic molecules that are that serve as the monomer. So, nucleotides are the monomers units for forming the nucleic acid polymers. So, nucleic acid is the polymer whose monomer is the nucleotide monomer means single unit, right.

Monomer is the single unit, for example, though it is not a part of it, but still like starch is the polymer of the monomer. Which one is the monomer? Monomer is the glucose. So, starch is made of the polymer starch is the polymer made of the monomer that is the glucose. So many glucose units are connected and that is how it becomes a polymer.

Like I gave another example that is like ethylene CH 2 double bond CH 2, right; so, ethylene when they are polymerised means n number of ethylenes are being added then it becomes polyethylene, right. So, which normally we know as polythene every now and then we come across, right. So, that is made a monomer is ethylene and the polymer is polythene or polyethylene.

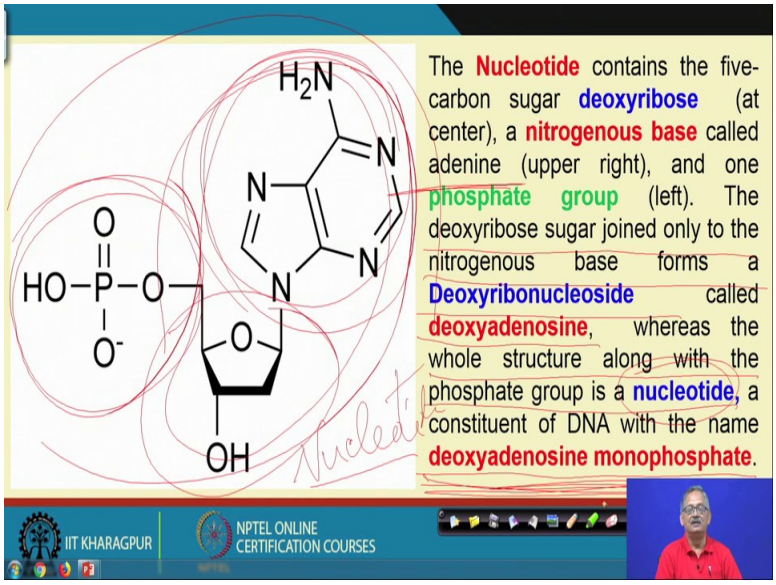
Similarly, here the monomer is nucleotide and that the nucleotide is what? It has a sugar group it has a nitrogen group and it has a phosphate group all three put together is forming that nucleotide and they are either if the sugar base is if the sugar base is ribose it is ribonucleic acid RNA or if it is the derivative of ribose or derived from ribose that is

called deoxyribose that is called DNA or deoxyribonucleic acid right and these are the unit block for the life called nucleic acid, right.



So, we come again that that nucleotides are organic molecules that serve as the monomer units for forming the nucleic acid polymers as deoxyribonucleic acid or DNA and ribonucleic acid or RNA, both of which are essential bio molecules in all forms of life on earth.

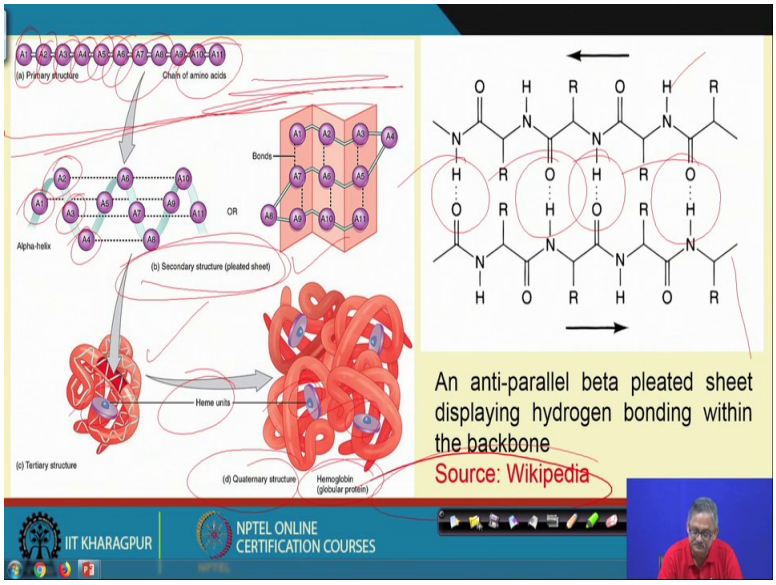
Nucleotides are the building blocks of nucleic acids they are composed of three subunit molecules for example, as we said nitrogenous base a 5-carbon sugar that is ribose or deoxyribose and at least one phosphate group these three are essential. They are also known as phosphate nucleotide. They are also known as phosphate nucleotide like this one, right. They are also known as phosphate nucleotides.



So, this looks like this ok. This looks like this that this is the phosphate unit, this is the nitrogenous compound and this is the sugar base compound right. So, all these three are linked connected then only it is forming that building block are called nucleotide, right. Here we write nucleotide right.

So, this nucleotide then we have explained here that is the nucleotide contains the 5-carbon sugar deoxyribose at the centre this is one and a nitrogenous base called adenine, this is the nitrogenous base this is called adenine and one phosphate group, this is the phosphate group that is a called the phosphate group, right.

The deoxyribose sugar joined only to the nitrogenous base that forms a deoxyribonucleic acid called deoxyadenosin, right dehydro deoxyribonucleic acid also can be said as deoxyadenosine whereas, the whole structure along with the phosphate group is a nucleotide, right. So, deoxyribonucleoside and this is also deoxyadenosine whereas, the entire thing is known as the nucleotide. That is the constituent of a DNA with the name deoxyadenosine monophosphate that is the entire thing deoxyadenosine monophosphate, right. So, this is how the nucleotide comes into play how detail we have said.



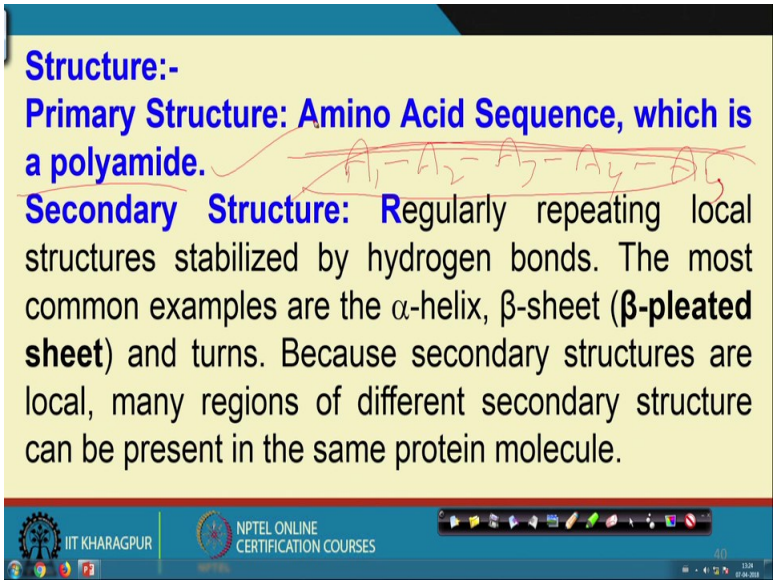
Now, from this nucleotide let us go to the protein part. That is, we said the four forms that is the primary, secondary, tertiary and quaternary, right. So, again this one I have taken from the source I have given that this is the source from Wikipedia, we have taken ok.

So, here we see an anti parallel, but an anti parallel beta pleated sheet displaying hydrogen bonding within the backbone. So, hydrogen bonding is happening here, hydrogen bonding is happening here, hydrogen bonding is happening here this is the backbone, right the hydrogen bonding is happening here. So, these are the hydrogen bonding which is linking this part and this part through this hydrogen bonding, right.

So, there are also another sulphidryl or sulphur disulfide bonding that also we will come, right sub subsequently we will come hopefully this thing we should finish today otherwise we will be lacking. So, let us look into that primary structure is like this that is the straight forward primary structure where these are the amino acids right A1, A2, A3, A4, A5, A6, A7, A8, A9, A11 just given a primary structure that is straight forward amino acids are linked, right.

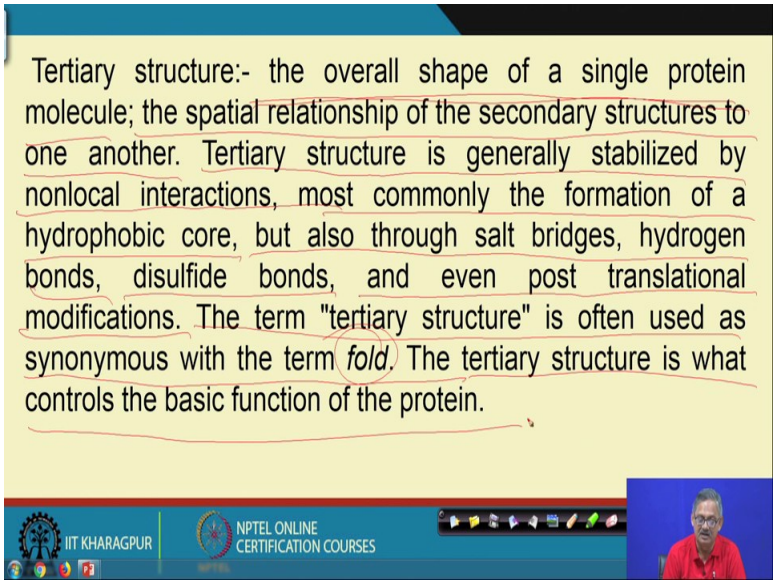
Then it is the secondary or pleated sheet, secondary or pleated sheet is like this that this is like a pleated sheet, right, sheet which is pleated where A1, A2, A3, A4 and they are all connected. So, like that it appears to be a pleated sheet, right or it can also be looked into like this, right these are the bondings these are the bondings or this is A1, A2, A3, A4, A5, A6, A7, A8, all like it is a secondary structure or pleated sheet.

Then, tertiary structure you see it is much more difficult, right like a coil or things like that it is much more much more complicated, right. So, here there is a heme unit or here there is a heme unit here there is a heme unit, right. So, heme unit means haemoglobin or globular protein, right and that is the quaternary even much more complicated than this, right this is this can also be in the form of a helix which called helical structure, right.



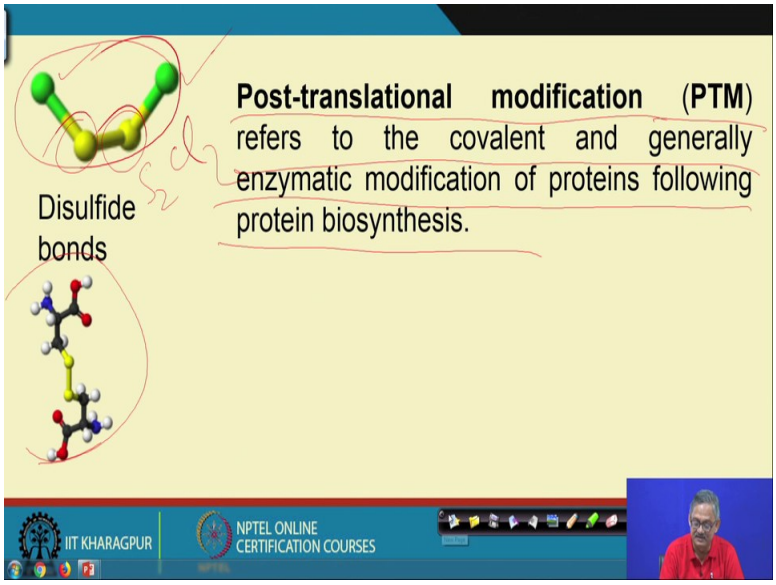
So, let us look into then structure that is the primary structure we should finish today all the structures. The primary structure is amino acids sequence which is a polyamide. Primary structure is a amino acid sequence which is a polyamide right we have said that amino acid A 1, A 2, A 3, A 4, these are all in the sequence A 5, like that as many you can think of as many you can as many you can put. So, the accordingly it will be so much, right. So, this is the amino acid structure or called the sequence of amino acids which is a polyamide.

Secondary structure which is regular which is regularly repeating local structures stabilized by the hydrogen bonds, hydrogen bonding is there which we have shown there. The most common examples are the alpha helix or beta sheet which is also known as beta pleated sheet, beta pleated sheet and turns because secondary structures are local many regions of different secondary structure can be present in the same protein molecule, right because it is a local. So, that is why many regions of different secondary structures can be present in the same protein molecule, right.



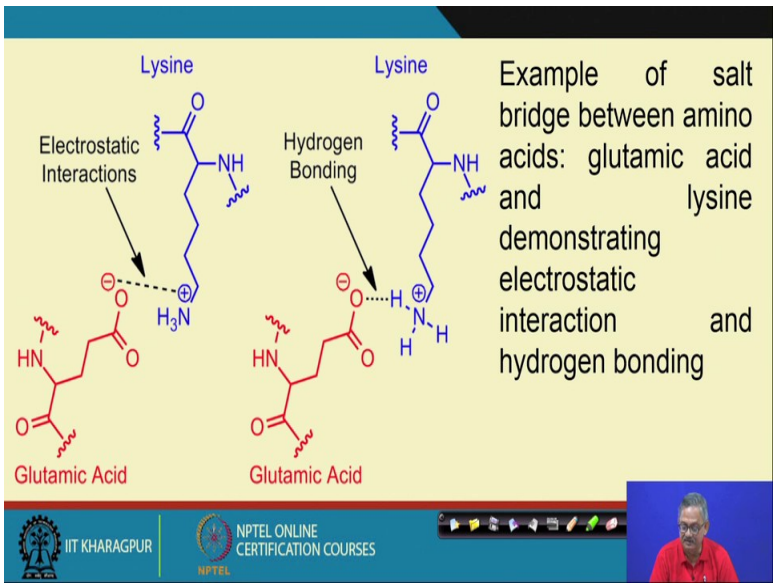
Then it comes to tertiary structure. So, tertiary structures are those where the overall shape of the overall shape of the of a single protein molecule. This is the overall shape of a single protein molecule where the spatial relationship of the secondary structure to one another. So, overall shape of a single protein molecule the spatial relationship of secondary structures to one another. One secondary structure to another secondary structure in their spatial, that is, 3-dimensional arrangement.

Tertiary structure is generally stabilised by nonlocal structures, most commonly the formation of a hydrophobic core, but also through salt bridges, hydrogen bonding, disulfide bonding and even post translational modifications. The term tertiary structure is often used as synonymous with the form of fold. The tertiary structure is what controls the basic function.



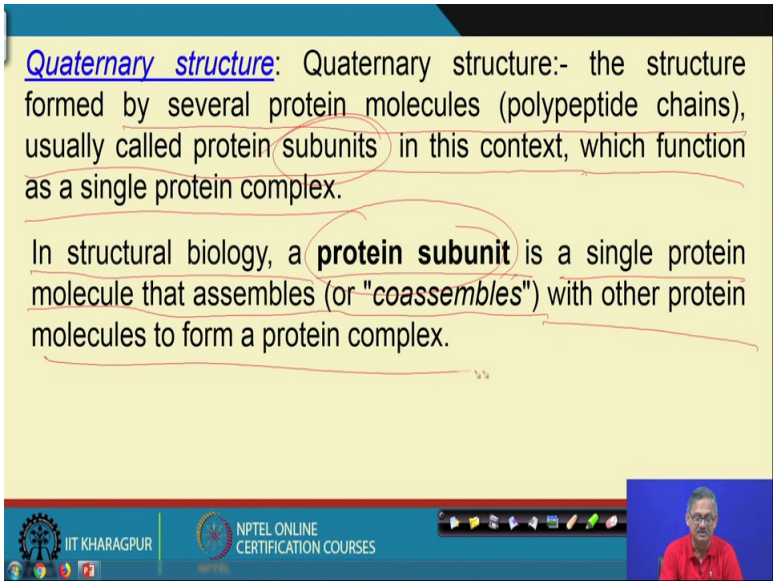
Then, it comes to quaternary, right. So, of course, we have seen that this is the disulfide right, this is the disulfide. So, if this is another sulphide with chlorine. So, this is S 2 Cl 2, right.

Similarly, this is another sulphide this is a multi block of may be multi this amino acids, right and in there we have said another term called post-transitional post-translational modification or PTM this refers to the covalent and generally enzymatic modification of the proteins following protein synthesis, right.



So, the last one which we have is the or this is another example of salt bridges which we have given, right. These are the salt bridges, that means, both you have here hydrogen

bonding as well as ionic. So, that is covalent and hydrogen bonding and ionic bonding together that is called the you your this salt bridges, right.



Then we come to quaternary because this is the last and this is quaternary structure the structure formed by several protein molecule that is polypeptide chains usually called protein subunits in the in this context which function as a single protein complex.

So, in structural biology a protein subunit right subunit here we said the structure formed by several protein molecules polypeptide chains usually called protein subunits and this subunit is a single protein molecule that assembles or coassembles with other protein molecules to form a protein complex, right.

So, I think we are running really out of time. So, let us call it a day and again, we will now come to the real protein in the milk in the subsequent class.

Thank you.