Enzyme Sciences and Technology

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Module - 01
Introduction
Lecture - 05
Enzyme Nomenclature

Hello everyone this is Doctor Vishal Trivedi from Department of Biosciences and Bioengineering IIT Guwahati and what we were discussing we were discussing about the different properties of the Enzyme. So, and in this context in the previous lecture we have discussed about the classification of the enzymes and in detail we have discussed about the classification of the enzyme into the 6 different groups. So, these are oxidoreductase, transferases, hydrolases, lyases, ligases is an isomerases.

So, all these groups are constituting a very large number of enzymes and these enzymes are you know playing a crucial role in running the different metabolic reactions. So now, the question comes when we are identifying a new enzyme which is catalyzing a particular reaction. How we are actually going to give the name to that particular enzyme?

So, in today's lecture we are going to discuss about the nomenclature of the enzymes and what are the different rules which we have to follow while we are giving a name a particular enzyme and what are the different precautions we should take.

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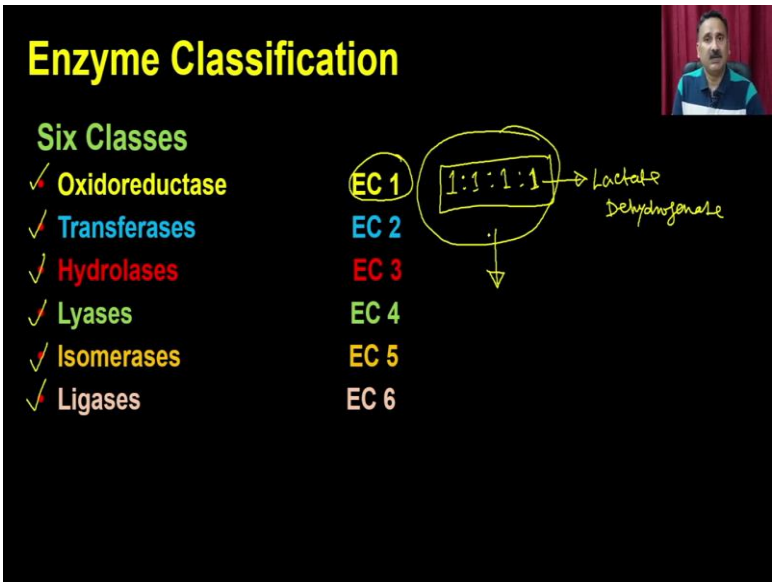

So, let us start today's lecture. So, what you can see here is that we have the enzyme classifications and in the enzyme classifications we have classified the enzyme into the six different groups right. So, we have oxidoreductase, we have transferases, we have hydrolases, we have lyases, we have isomerases and we have the ligases and all these classes are being given to their respective enzyme commission number or EC number.

But the EC number is one of the way in which the enzymes are being you know given some kind of nomenclature. For example if we have the EC number as 1 is to 1 is to 1 is to 1 that is actually corresponding to an enzyme which is called as the lactate dehydrogenase right. So, instead of writing the Lactate Dehydrogenase we can also write the this as a name, but in practicality it is very difficult to write the name of an enzyme like this right.

Because it is going to be very very cumbersome when we say that and you eat the conversion of pyruvate to lactate is being catalyzed by an enzyme which is is 1 1 1 1 1 right. So, that is not the way in which the enzymes are being given the name. So, there is a complete history in which by which the enzymes are being given the name. So, let us see what are the different ways in which the enzyme nomenclature is being evolved over the course of time.

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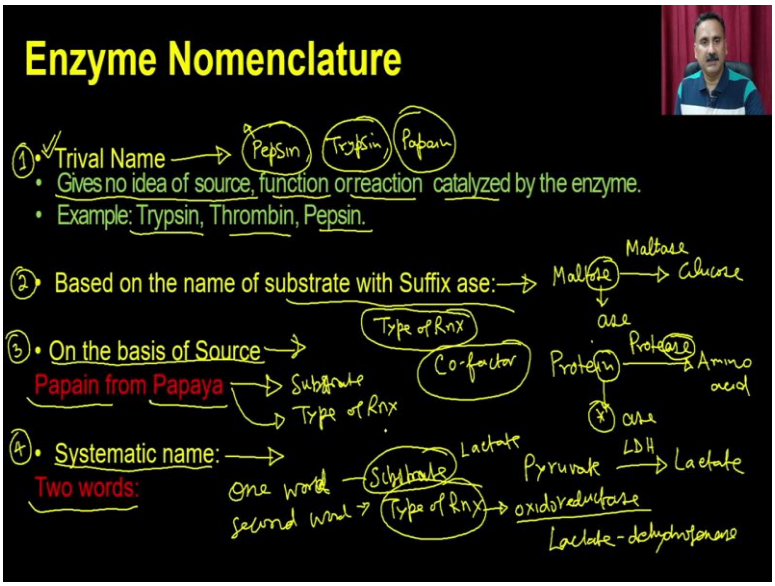

So, initially when the field of Enzymology started people have started giving the name randomly or based on the source of the enzyme from where the enzyme is being recovered. So, that has been given like a trivial name ok. So, the Trivial Name or classical example is like the pepsin, trypsin and papain.

So, trivial names are the name which are popular people have say you know, but they were not giving any classical information. So, these are important in terms of historical point of use, but they are not giving any information's. So, when you see that pepsin it does not give any information about the substrate of that enzyme, it does not give any information what reaction it catalyzes and so on.

So, it gives no idea of the source from which the enzyme is isolated it gives the no idea about the functions or the reaction what it catalyzed and so on. So, classical examples are trypsin, thrombin, pepsin and so on. Then the second way of giving the name is that it is based on the name of the substrate with the suffix ase.

For example, if we have an enzyme if we have a reaction which is like the maltose getting converted into glucose right and if we want to write the name of this enzyme what we have to do is we have to remove this ose right. So, we can remove the ose and replace it with the ase, so if we do that the enzyme name would be maltase right.

Similarly we can have the some more enzymes name like for example, if we have an enzyme which is degrading the protein. For example, so if we have an enzyme which is degrading the enzyme a protein then the it is going to catalyze this reaction right, it is the amino acid right protein to amino acid. So, what we have to do is we have to remove this in so we have to remove this and instead of this we can just put the ase. So, the enzyme name would be protease ok, so we have ase at the end of the prote right.

So, that is the way people have started giving the name, but with this the problem is that it does not provide the information about the type of reaction what it catalyzes ok. It does not so it is fine as long as the name of the enzyme is concerned, but that name does not give more information in terms of the type of reaction it catalyzes, whether it utilizes some co-factors and all other kind of things.

Then the people have also started another way of putting the name that is the third way in which they are actually giving the name on the basis of source of the enzymes. Like for example, the papain, so papain is an enzyme which has been isolated from the papaya, but that also has many problems like it gives the source, but it does not give any information about the substrate it does not provide the information about the type of reactions and so on ok.

So, then people came up with the 4th idea and the 4th idea is that they were started using the Systematic name. Systematic name means with their where they are started using the 2 words one is. So, one word is for the first word is actually for the type of substrate what it is utilizing and the second word is actually the is for the type of reactions ok.

For example, Pyruvate is getting converted into lactate right and this reaction is been catalyzed by an enzyme which is called as LDH. So, the name is based on the substrate and type of reactions. So, substrate in this case is lactate and the type of reaction is that it is catalyzing a oxidoreductase reactions right.

So, that is why the name would be lactate dehydrogenase because this is a dehydrogenation reactions. Now, this is also having the lot of issues right it also have the problems, so that is why people have come up with the set of guidelines and the rules which has to be follow to give the name to a particular enzyme isolated from any source or in or what whatever the properties of that enzyme to catalyze some reactions.

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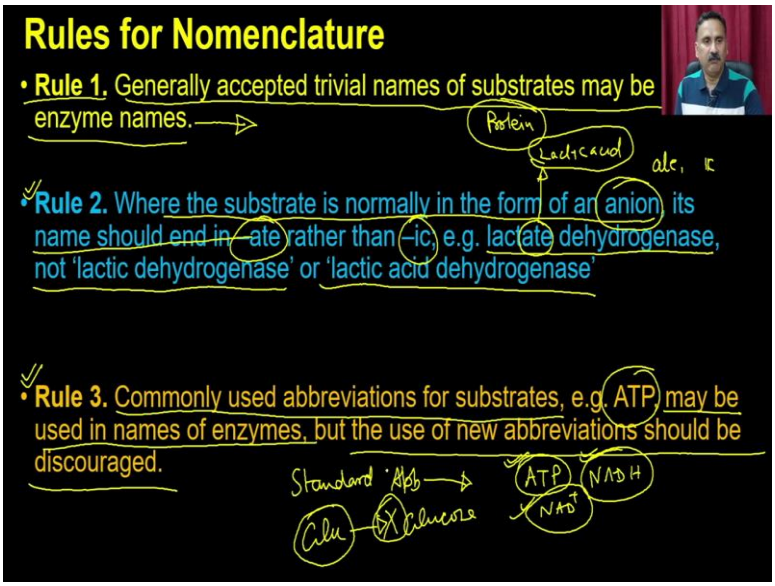

So, what are these rules these rules are rule 1 ok. So, what is the rule 1 generally accepted trivial name of the substrate may be used in the enzyme name. So, when you are you giving the name of an enzyme, you should use the classical name of that substrate.

Which means you are going to use the name as protein and standard name ok, you are not going to use any other name like maybe the protein is been called something else in some other way, but that should not be the case. Should be a standard name what we have to use in case we are using it for the nomenclature of the enzyme.

Then the rule 2 is that where the substrate is normally in the form of an anion ok, it is name should end in ate which means rather than ic. For example, lactate dehydrogenase that is the enzyme name of the enzyme and it ends where the substrates name ends in the ate, this means it is actually having a lactic acids anion group, which means it is actually having a lactic acid anion actually which is present as a substrate.

So in that case we are going to give the name as lactate dehydrogenase. So, we are going to use ate rather than ic ok, which means we are not going to say lactic acid we are going to say lactate actually. So it is not going to be called as lactic dehydrogenase or lactic acid dehydrogenase, then we have the rule 3.

So, rule 3 is that the commonly used abbreviation for the substrates, for example the ATP may be used in the name of enzyme. But the use of new abbreviation should be discouraged, which means we have to use the standard abbreviations whatever we have been using for different types of substrates or even for the cofactor.

For example, ATP, NADH, NAD plus or something like that ok, so for them it is there is a there is a flexibility that you cannot you can use them. But it is not like you are using you are started using any abbreviation now for any substrate. For example, if I am started writing Glu for glucose right that is not allowed that is not allowed because you are you writing it only for the sake of making it very simple for your own understanding, but this is not the standard abbreviation for the glucose. So, that is what.

So, you have to use the abbreviation like the ATP, NADH, NAD coenzyme a and all that, but not like this.

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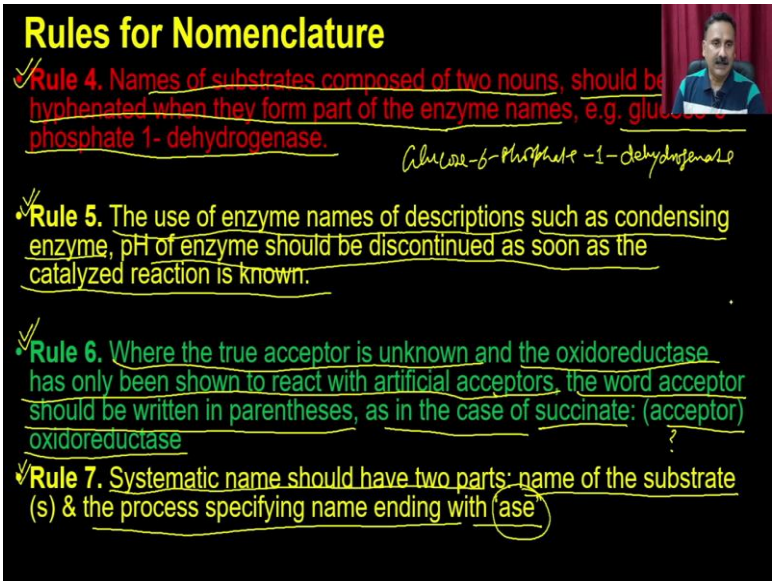

Then we have the rule 4 and the what is rule 4 rule four is that the name of the substrate composed of 2 nouns should be hyphened when they are form of the form the part of the enzyme name. For example, glucose 6 phosphate 1 dehydrogenase ok. So, in this case glucose and the 6 phosphate so if there is a hyphen which is been put.

So, that the it is actually you know when it is present of the part. For example, it can be written like this glucose-6-phosphate right, but when it is a part of the enzyme it has to

hyphened and then it has to be written like dehydrogenase ok So, we cannot write glucose 6 phosphate dehydrogenase it has to be hyphened in between the name of the substrate and the dehydrogenase.

Then in the rule 5, rule 5 is the use of the enzyme name of the descriptions such as condensing enzyme pH of the enzyme should be discontinued as soon as the enzyme catalyze reaction is known. Which means if you have discovered a new enzyme in that case you can actually use these you know then in the name you can say that it is condensing enzyme ok, you can say whatever the way to describe this enzyme.

But once you characterize that enzyme you know the mechanism of reactions, you know what are the cofactors are involved then these has to be discouraged. Because until you do not know you can actually be used this kind of terminologies, but once you know the biochemical understanding of that then it can be done.

Then for the rule 6 where the 2 acceptor is unknown the oxidoreductase has only been shown to react with the artificial acceptor, the word acceptor should be written in the parentheses as in the case of succinate a acceptor oxidoreductase. Which means in some cases when you are actually you know looking at the reactions it is very it is unclear that who is going to be the acceptor or electron acceptor.

In this case; then in that case you can write this name of the substrate acceptor and oxidoreductase which means acceptor is unknown as soon as you will know the acceptor you will write the name of the acceptor and that is how you are going to write the name of the oxidoreductase.

Then the rule 7, rule 7 says that the systemic name should have two parts name of the substrate and the process specifying the name ending with the ase. So, in some cases you also write the name of the process ending with the ase also. So, these are the 7 rules or guidelines what you supposed to follow while you are giving the name of an enzyme.

But as you know that the enzymes are been classified into 6 different groups and all these 6 different groups are actually having their own way of giving the name. So, let us discuss all these in detail.

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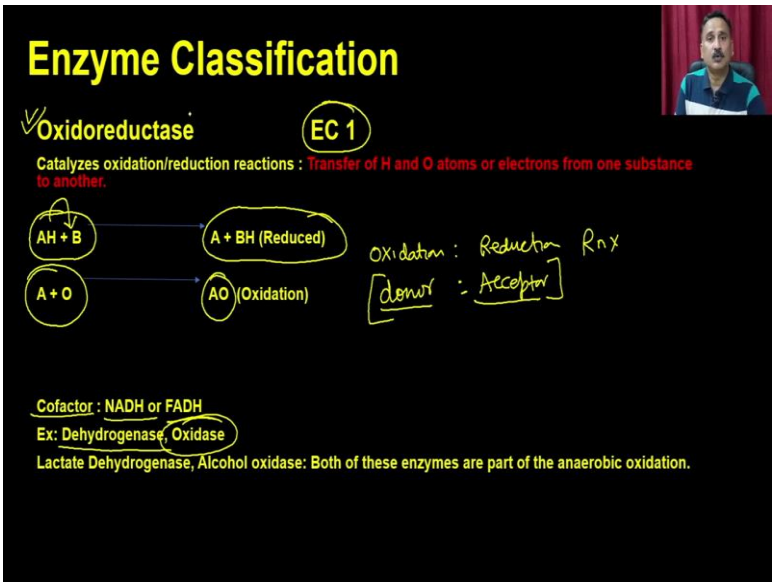

So, the first enzyme group is the oxidoreductase which is belonging to the EC 1 and it is catalyzing a reaction where it is taking up the proton or hydrogen from the one substrate and it is giving it to the other substrate and that is how it this is the reduction reactions, in the other reactions it is oxidizing the substrate to form the oxidized product.

So, it is basically catalyzing a oxidation reduction reactions right. And since it is catalyzing the oxidation reduction reactions it is actually having a donor as well as acceptor molecules as a part of the reaction mechanism. And that is why the donor and the acceptors are very very specific or very very unique to this particular enzyme ok.

So, in this case cofactors what you use is NADH and FADH to and classical examples are Dehydrogenases and Oxidases. Now, the in how you are going to give the name to a particular enzyme belonging to the Oxidoreductase family.

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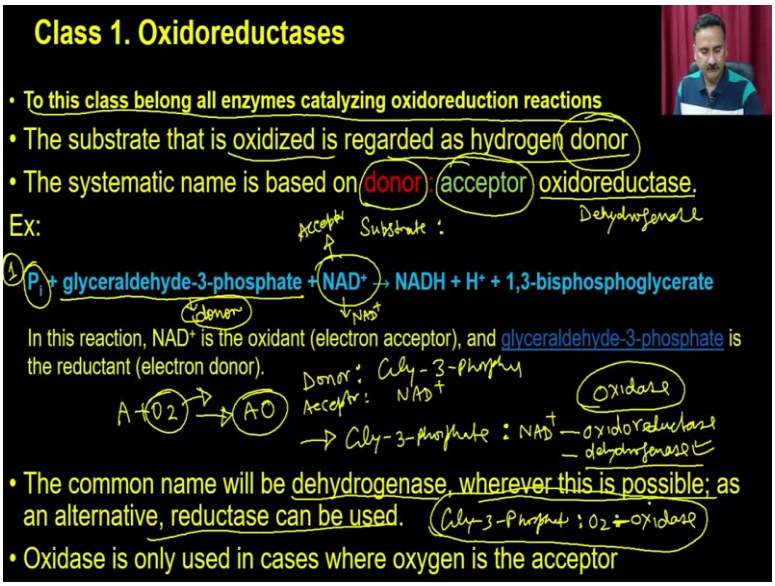

So, to this class belong all enzymes catalyzing the oxidation reduction reaction, which means the substrate that is oxidized is regarded as the hydrogen donor ok. So, the systemic name is based on the donor. So, you should know the name of the donor then you should know the donor name of the acceptor and then it is going to be write as oxidoreductase. In some cases people also write the dehydrogenase ok. So, as I said you know the substrate that is going to be oxidized is going to be called as donor.

So, its means you are first going to write the substrate which is always going to be the donor, then you are going to write the semicolon and then you are going to mention the acceptor. In most of the cases the acceptor is going to be the sum of the cofactors what is involved in these particular reactions.

So, for example, either it will be NAD or it will be NADH or some other cofactors and then you are going to write either the oxidoreductase or dehydrogenase. I have taken an example for example, in this case this is a reaction where the phosphate plus glyceraldehyde three phosphate plus NAD plus and it is giving a NADH plus 1 3 bisphosphoglycerate ok. So, what you see here is that who is the donor ok? So, if you see here is that this is the substrate ok and this is going to be the donor in this case ok.

So, if it is a donor you have to you have then you have actually the 2 molecules you have a Pi you have NAD plus as an acceptor, but in this case the acceptor is NAD plus right.

So, once you know that this is the acceptor. So, NAD plus is a acceptor so ok. So, in this case donor is glyceraldehyde 3 phosphate right and acceptor is NAD plus.

Now if I have to write the scientific name of this enzyme then I will write is glyceraldehyde 3 phosphate semicolon because this is the donor right and then I will write the name of acceptor. So, it will write NAD plus and then I will write oxidoreductase or in some cases I can write also dehydrogenase, dehydrogenase is more popular compared to the oxidoreductase.

But ideally the in the rules it says that donor acceptor and oxidoreductase that should be the name which is written. But classically we are using the dehydrogenases because it is basically doing nothing but it is removing dehydrogen, so that is why it is written as dehydrogenases also.

The common name which is dehydrogenase is also been used wherever it is possible as an alternative reductase can be used ok, oxidase is only been used. So, in some cases we write the instead of oxidoreductase or dehydrogenases we also write oxidase in ok we only write the oxidase when it is actually like this A plus O2, which means if it is only oxygen percent there is no other substrate and there is a oxidation is happening which means it is forming this, then only we are writing the oxidase.

If it is doing both if it is doing the reduction reactions and it is doing the oxidation, because whenever you do have oxidation reactions one substrate is getting reduced the other substrate is getting oxidized right. So, in those cases we are going to use the dehydrogenases, but if it is only doing the oxidations then you are going to use the term as oxidase right. Then in that cases the oxygen is going to be the acceptor.

So, if it is a oxidase for example, in this case only if you have glyceraldehyde 3 phosphate plus O2 giving some product then you are going to write like this ok, your what you are going to write you are going to write glyceraldehyde 3 phosphate. So, that is the sub donor right then you are going to write O2 and then you are going to write oxidase ok. So, you are going to write like this. So, that will be the way in which you are going to write the reaction where the substrate is been oxidized by the enzyme.

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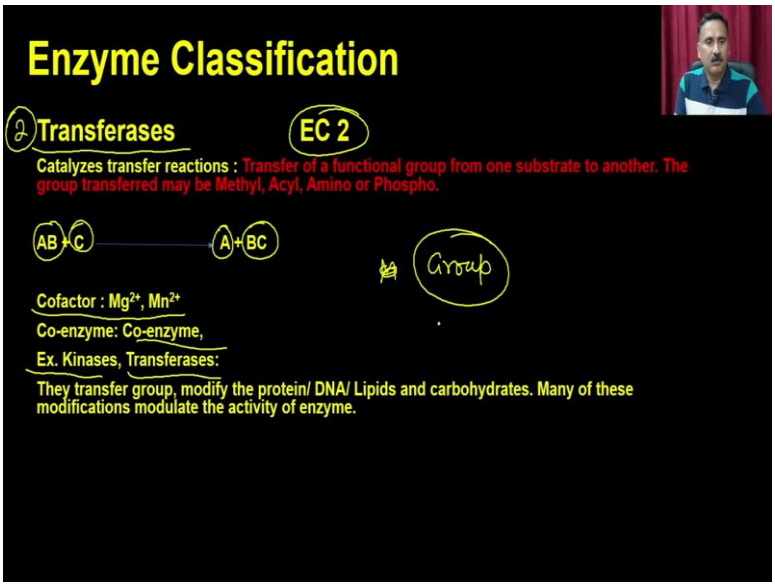

Now let us move on to the 2nd class. So, 2nd class is the Transferase which is belonging to the EC class 2 and it catalyzes the transferase reactions. So, AB plus C is going to give you A plus BC and the cofactor is magnesium or manganese and coenzyme the enzyme this is the biggest you know class in the enzyme class and the it normally transfers the methyl groups.

So, basically in this case you are actually have to focus only the group what it is actually going to transfer and that is why based on taking that into account you can be able to give the name of the different enzyme, what is belonging to the transferases.

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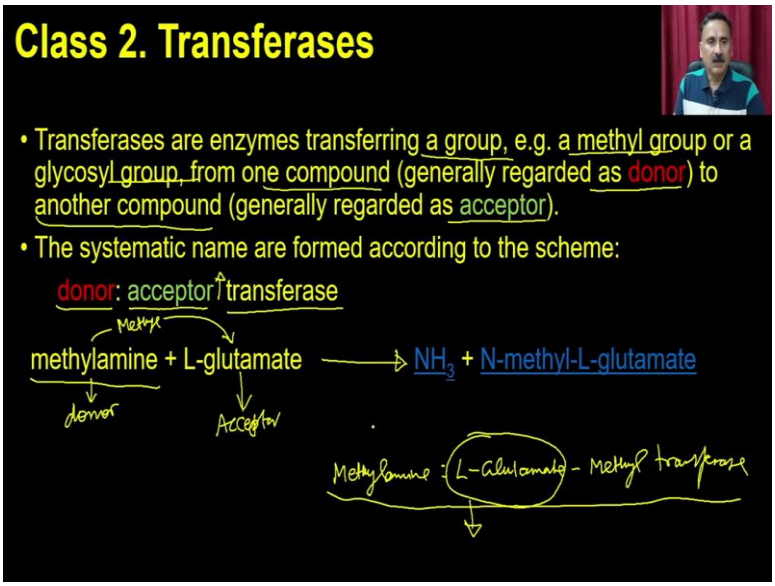

So, how you are going to write the name of enzyme? For example, so transferases are enzyme transferring a group for a methyl group or a glycosyl group from one compound. So, when the compound from which it is actually going to take the methyl group that is going to be considered as donor and the compound what is going to receive this particular group is going to be called as acceptor.

So, just like as we have discussed about the oxidoreductase class here also there will be a donor and there will be an acceptor ok. So, you have to just identify the donor and you have to identify the acceptor and then you can be able to write the name. For example, so the systemic name is going to be follow this formula donor semicolon acceptor transferase ok.

So, for example this is the reaction where the methylamine plus L glutamate giving you the ammonia and N methyl glutamate ok. So, this is the reaction what it is been catalyzing. So, in this case basically what is happening is that there is a methyl group what if been taken up from the l methylamine and that is how it is actually forming the N methyl L glutamate ok. This means this is going to be the donor right and this is going to be the acceptor and the transferase ok.

So, in some cases you also write what group it actually transfers as well right. So, if I write the name of this enzyme it will say methylamine semicolon L glutamate methyl transferase ok. So, what it says is that L glutamate has taken a methyl group from the

methylamine ok and that is why you see the enzyme name itself provides lot of information it provides the information what kind of reaction it catalyzes, because it has a transferase at the end then it also says what are the different components.

Because if you looking at this name itself you can be able to write this whole reactions and that is why people are going with this systemic name of writing the different enzymes.

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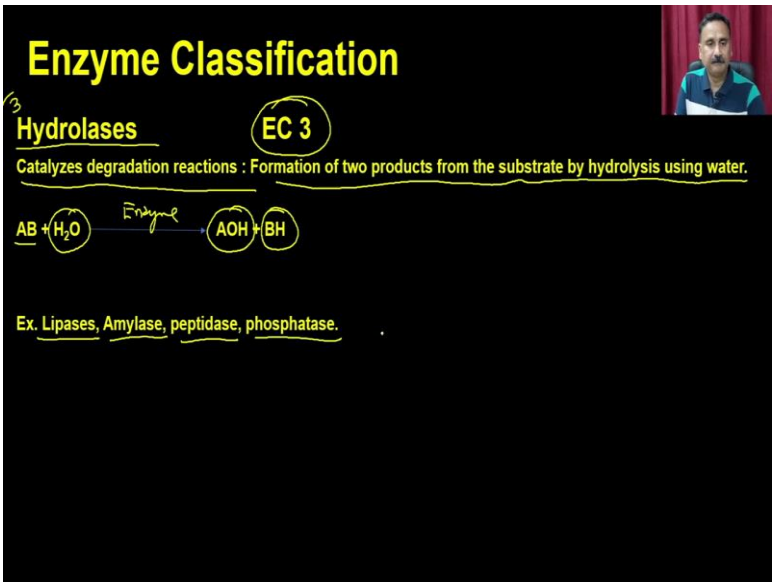

Now, we will talk to the third group and the third group is the hydrolases which is belonging to the EC class 3 and it catalyzes a degradation reaction which means the formation of 2 products from the substrate by hydrolysis using the water, which means if this substrate AB it reacts with water in the presence of the enzyme, then it is actually going to call the AOH plus BH ok. Classical examples are Lipases, Amylases, peptidases and phosphatases.

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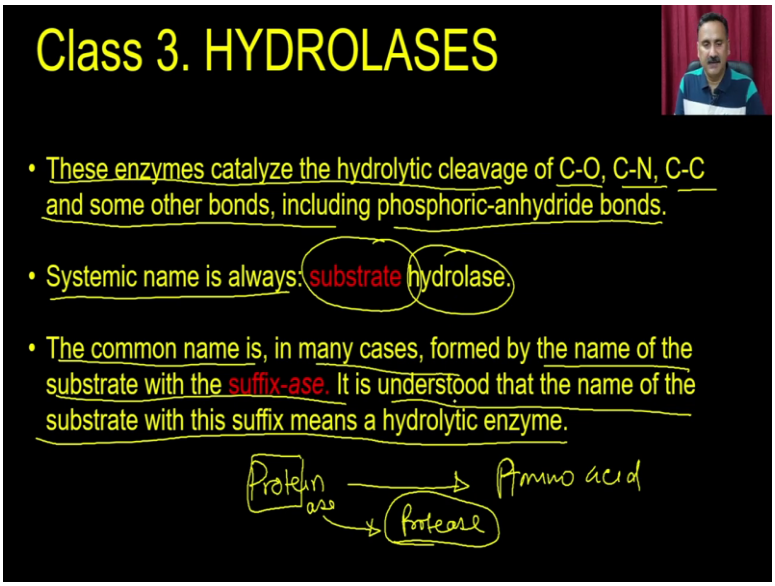

How you are going to write the name of the hydrolyses? So, these enzyme catalyzes the hydrolytic cleavage of C-O, C-N, C-C and all those bonds including the phosphoric anhydride bonds. So, systemic name is substrate hydrolase, which means substrate hydrolase ok. So, the common name in many cases formed by the name of the substrate with the suffix ate.

It is understood that the name of the substrate with this suffix mean a hydrolytic enzyme. For example, protein giving amino acid right, so if I have to write the name of this what I will do is I will just to take this and I will add the ase ok; so that will be protease ok. So, this is the simplest class simplest class, where you can actually have you do not have to identify the donor acceptor and all that and you just take the substrate name and then you put the ase and that is actually going to give you the name of the enzyme.

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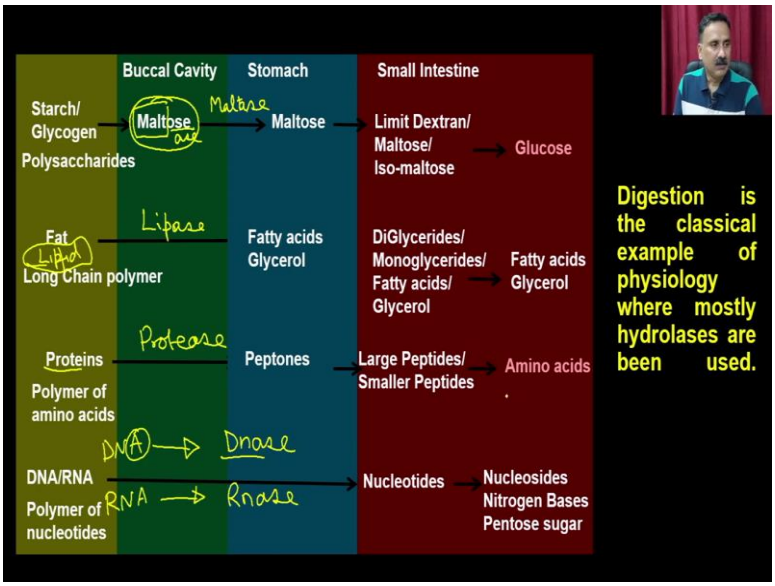

Here I will take the some examples from the Buccal cavity or from the elementary canal which is actually the full of you know protease 4 of the hydrolytic enzymes. So, for example, if the substrate is Maltose and if it is degrade getting degraded right then the enzyme name is Maltase. So, what I did is I took the malt then instead of ose I put the ase. So, that will be the enzyme name.

Similarly, if I have the Fat and it is getting converted into Fatty acid, so Fat is also called as Lipid right. So, I can just write Lip right and ase so I have taken this and I have put the ase. Similarly for the protein when it is getting converted into peptones. So, what I will do is I will take this much and then I will put the ase, so I will put protease.

For even for DNA and RNA, so if it is DNA then what I will do is I will and here you see I have taken the abbreviation, I have not taken the full name of DNA because that that kind of abbreviation is allowed. So, what will be the name of the enzyme Dnase, so I have removed this A and I have put ase; actually if it is RNA then it is going to be Rnase Rnase ok. Similarly you can have nucleotides you can have the even other kind of amino acids other kinds of enzyme as well.

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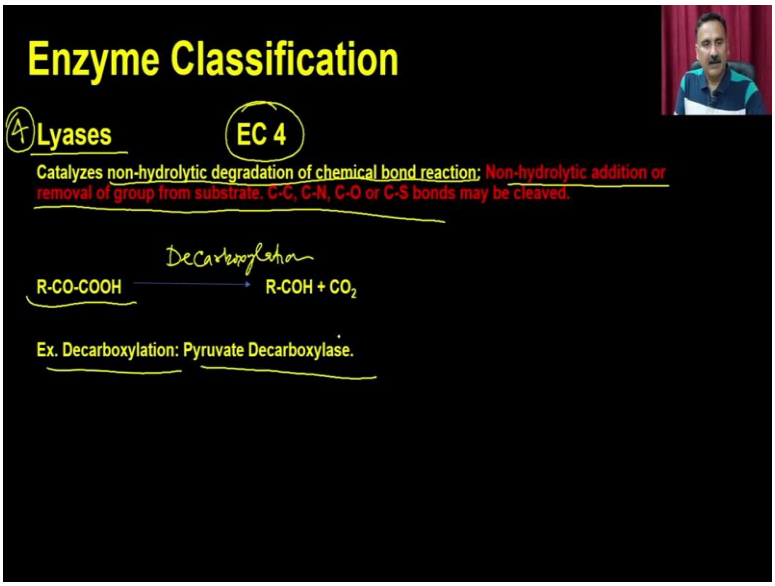

Now let us go to the next class. So, next class is the Lyase which is belonging to the EC class 4 and it catalyzes the non hydrolytic degradation of the chemical bond or the non hydrolytic addition or the removal of group from the substrate. Classical example is this reaction what is going to be catalyzed right which is a decarboxylation reactions right. So, decarboxylation reaction examples are Pyruvate Decarboxylase.

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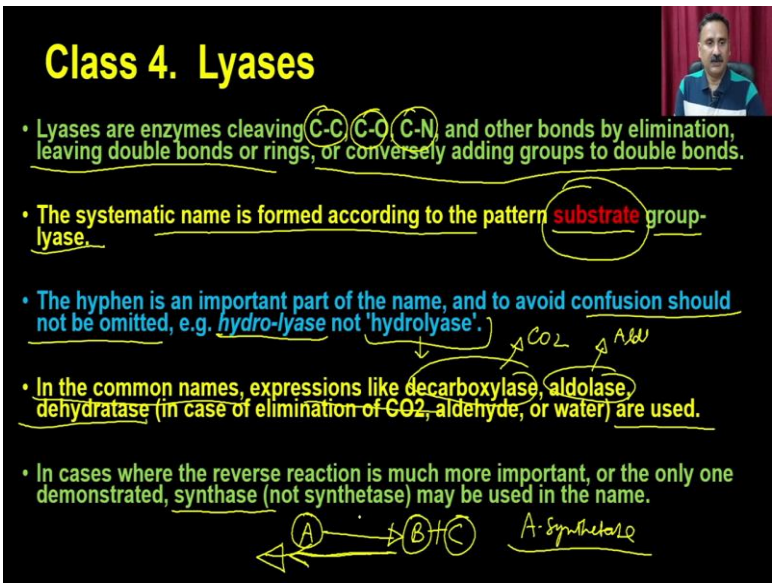

For Lyase there are set of rules Lyase are enzyme which are cleaving the C-C, C-O, C-N and other bonds by eliminating leaving the double bond ring or converting or adding the

group to the double bond. The systemic name is formed according to the pattern like the substrate then followed by the group and dash you are going to write the lyase.

The hyphen in the lyase case the hyphen is very important part of the name and to avoid confusion should not be emitted. For example, hydro lyase hydro lyase, if you do not put the hyphen then it will become hydro lyase right and that will give the false impression that it is actually a hydrolytic enzyme ok. Which means it is utilizing the water, but in it is just not like that it is actually a lyase actually instead of the protease or some other kind of things ok. So, hydro lyase so that hyphen is very important.

In the common name the expressions like the decarboxylase, aldolase, dehydratase because decarboxylase means the enzyme which removes the carbon dioxide or aldolase means the enzyme, which actually degrades the aldehyde or in some case of dehydratase which is actually going to remove the water are also very commonly been used.

For example the pyruvate decarboxylase right, so pyruvate that is the substrate right and the decarboxylase is we have actually clubbed the group as well as delyase. So, that is why it becomes pyruvate decarboxylase. In cases where the reverse reaction is much more important or the only one demonstrated we also use the synthase rather than delyase actually. So, you can imagine like this right if A is getting converted into B plus C right like that ok.

But in some cases what happen is that B plus C is actually more pronounced it is a bigger reaction and it very rarely you will see that a is getting converted into B plus C, instead B plus C is getting converted into that. So, in that case you will write A synthetase instead of right, because this backward reaction is much pronounced then what is happen what is the product of this backward reaction that A is getting synthesized rather than A is getting degraded by the A lyase ok.

So, in that cases you always write the A synthetase as the name of this particular enzyme, because the enzyme is going to do the both reactions. But this enzyme actually catalyzes this reaction more efficiently compared to this reactions. Now let us move to the next class and the next class is the Isomerase ok.

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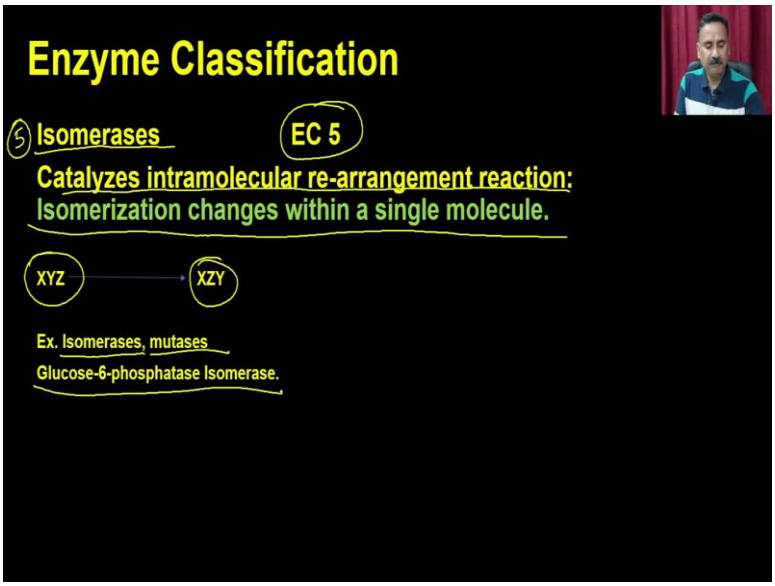

Isomerase which is belonging to the EC class 5 and it catalyzes the intramolecular rearrangement reactions, isomerization changes within a single molecule. So, it actually changes the groups within this right. And the examples are Isomerases, mutases classical example is Glucose 6 phosphate isomerase.

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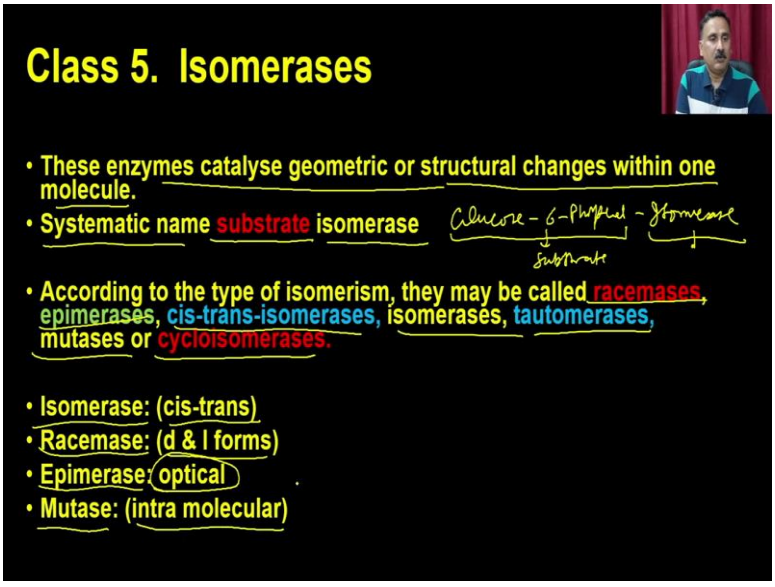

How you are going to write the name of this isomerases. So, this enzyme catalyzes geometric or structural changes within the 1 molecule. Systemic name is you write the

name of the substrate and then you write the isomerase for example, Glucose 6 phosphate isomerase.

So, Glucose 6 phosphate is the substrate, so if you write the Glucose 6 phosphate isomerase ok. So, this is going to be the name of substrate and this is going to be isomerase right. So, according to the type of isomerase sometime they are also been called as racemases, epimerases, cis-trans-isomerases, tautomerases, mutases and the cycloisomerases.

So, depending on type of the isomerism going to be catalyzed by that particular enzyme sometime we also write that also, because that gives the more information about the type of reaction it is going to catalyze. Because the purpose of writing the nomenclature is that it not only provides a name it also provides the type of reaction it is going to catalyze.

For example if a enzyme is doing the you know if it is catalyzing the epimerases right. So, in those cases we write the substrate and then epimerases. So, that will say that it is actually causing the isomerase isomerism, but that isomerism is belonging to the epimerism class. Isomerases for example, if it is a cis-trans modifications racemase if it is a d and l form epimerases if it is a changing the optical isomerism and if it mutates if it is a intra molecular rearrangements.

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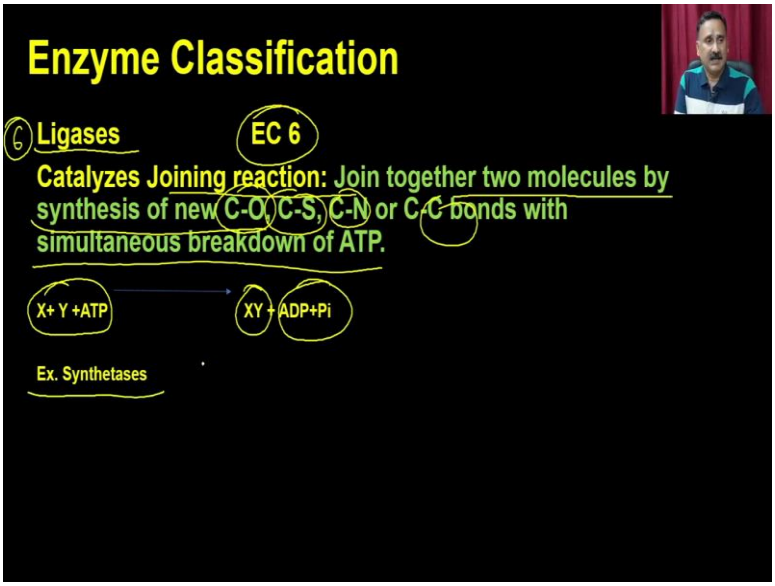

Then we come to the next last class and last class is Ligases or the EC 6 that catalyzes the joining reactions is joined together the 2 molecule by the synthesis of new carbon oxygen, all these bonds right with the simultaneously breakdown of the ATP. So, X plus Y plus ATP gives the XY and ATP plus Pi the examples are synthetases. So, ligases are exactly the reverse molecule compared to the lyases, the name of the ligase is also going to be very you know follow the simple rule.

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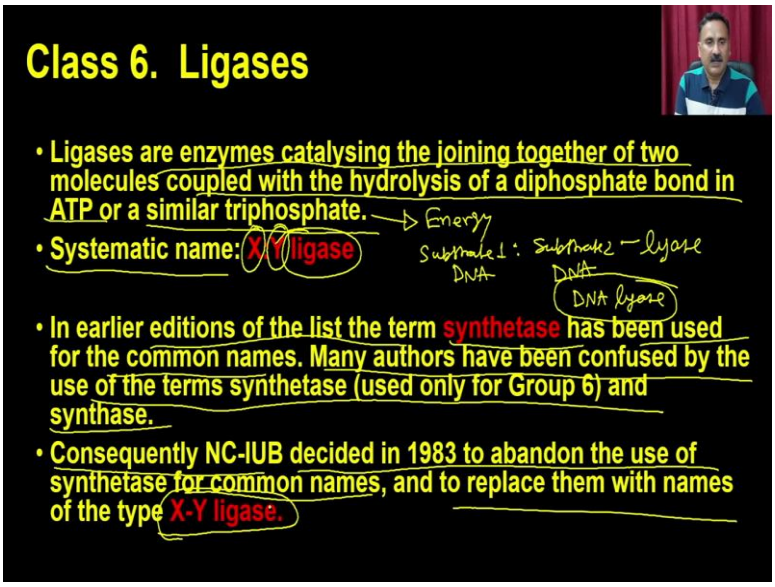

So, ligases are the enzyme which catalyzes the joining together of the 2 molecule coupled with the hydrolysis of a diphosphate bond in ATP or similar triphosphate molecule for providing the energy right. And the systemic name of the enzyme is that you are going to write the substrate 1 semicolon substrate two and then you are going to write the ligase ok. So, in earlier edition of the term synthetases has been used for the common names.

Many authors have been confused by the use of the term synthetases and the synthase and because of that this particular type of systemic name is been written, where you are going to write the substrate 1 semicolon substrate 2 and then ligase ok. If the substrate 1 and substrate 2 are same, for example if there is a ligase which is joining the DNA molecules 1 DNA molecule to another DNA molecule in that case the substrate 1 is also going to be DNA substrate 2 is also going to be DNA.

So, in that case we normally omit either of these substrate and we write DNA ligase right. So, that is a common name what common practice what people do actually if it is a RNA if it is the RNA DNA like that ok. Consequently the NC-IUB decided in 1982 abandon the use of synthetase for common names and for to replace them with the name of the type X-Y ligase ok.

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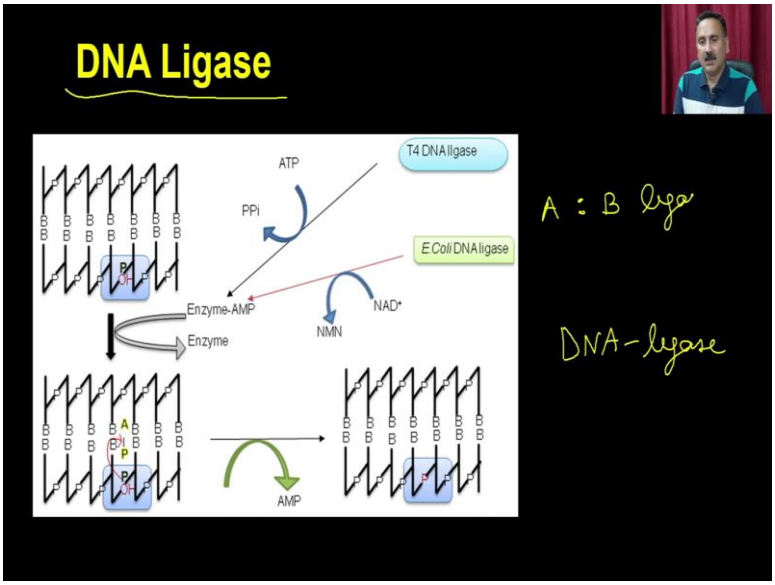

So, this X-Y ligase name is more acceptable by the scientific community. Such is what I was talking about if you have the DNA in both the parts like substrate 1 is also DNA subset 2 is also DNA then in those cases you are going to write the name of the enzyme as DNA ligase right. But in those cases where you have the 2 substrate like A and B then you are going to write AB ligase or.

So, this is all about the nomenclature of the enzymes. What we have discussed we have discussed about the discrete rules and guidelines what you are supposed to follow when you are going to give the name to a particular enzyme and then we have also discussed about the systematic pattern, which suppose which you have to follow to give the name to a particular enzyme class. So, with this I would like to conclude my lecture here.

Thank you.