Bioinorganic Chemistry
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Lecture - 10
Electron Transport Proteins – VI

We are just talking about this same haem molecule, which is showing different properties.

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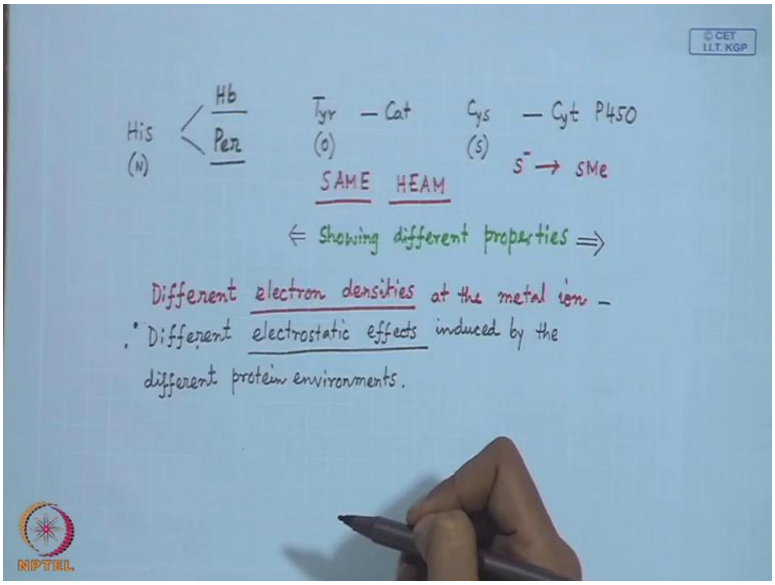

Why they are showing these different properties is we should… Before going to that dioxygenase system, little bit we should remember it that, in both these cases; that means for hemoglobin and peroxidase, it is the fifth coordination site, which is by histidine; for catalase, it is tyrosine; and for cytochrome P450, it is cysteine. So, you have the sulphur, you have the oxygen. Here you have the nitrogen coordination; here you have the oxygen from the fifth site; and here it is cysteine sulphur.

So, we do not have much option for the biological system; that we cannot go for other donor atom. But you see that, so much reaction, because large number of these type of monooxygenase molecules are available, which we can simply vary from nitrogen to oxygen and to sulphur. And, they are showing vast majority of different reactions. And, in some cases, we can see that, some of the copper based systems that, not only this sulphur; that means that not the cysteine sulphur, but the thioether sulphur; that means

the methionine sulphur. So, methionine sulphur also can control some reactivity, because it is not a charged one, but the sulphur has higher covalency. So, it can monitor the corresponding reactivity on the iron site.

How we can correlate? If we say that, when you have nitrogen, it has one type of reactivity towards dioxygen as well as the substrate; when you have the phenol oxygen or when you have the cysteine sulphur or thioether sulphur, all these different properties are related to different electron densities; which is very important. So, these different properties are related to different electron densities at the catalytic site, that means, at the metal ion site. So, this electron density is important. And, different electrostatic effects – how these different electrostatic is coming into the picture? Which are induced by the different protein environments.

So, there lies the importance that, the protein environment is simply controlling the electrostatic effect on the iron site, which we cannot get for the small molecule analog. That is why, in the laboratory, if you are able to make some compound, because large number of reactions do catalyze by this haem systems, that means, the iron porphyrin system. So, there is standard reagent. It has become a standard reagent that, if you have the haem type of system, that means, iron porphyrin; then, you add some external reagent; then, you go for the corresponding hydroxylation reaction.

And, if you are able to do some reactions, where you have the corresponding metal carbon bond; that means you have the organometallic compound. And, that organometallic compound, if you have a phenyl ring; and, that phenyl ring – if it can show some bond directly, because the most common metal center, there we all the time, we use the palladium center. If you have a palladium carbon bond, that bond can also be activated by this sort of reagents like metachlorophyta benzoic acid or hydroxybenzene. So, you directly can hydroxylate that particular benzene ring to its corresponding phenol analog. But, that is through a metal carbon bond formation; that is, through direct activation. But, here we are not going for that sort of direct activation reaction. So, coming from this monooxygenase behavior, now, we have some very good idea that, how you activate the dioxygen molecule; either from the dioxygen available from the air or you get that corresponding, because we know the reactivity pattern for the pheryl group formation. So, you add some reagent, which can generate the corresponding pheryl species.

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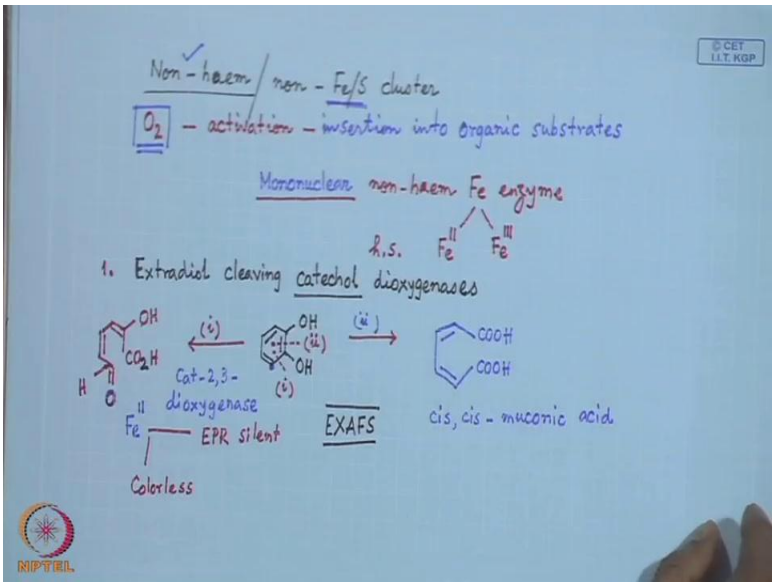

Now, for other iron containing proteins, that means, the dioxygenases. These dioxygenases we simply level like this; that means, they are non-haem proteins. So, immediately, we should know that, now, you do not have that porphyrin. Porphyrin you are just taking away. And, this is a non-haem protein; at the same time, is a non-iron sulphur cluster. What are these molecules basically? That means iron sulphur clusters – we all know that, they provide some electrons to the system. You have now that, O 2 molecule, which we want to activate. So, the activation of this O 2 molecule is important. So, it is activated; and, that activation and corresponding insertion into the organic substrate. Like that of the metal carbon bond formation, we go for the O 2 activation by the iron site and insertion, which is a very good catalytic term. We know that, insertion reaction into organic substrates.

Now, the challenge is that, you have to introduce both the oxygen atoms of the O 2 molecule. Since it is a non-haem center; then, next, we will find out this does not belong to any iron sulphur cluster. That how many metals centers are present over there? Whether it is a binuclear system or a trinuclear system or mononuclear system? It has been identified that, it is a simple mononuclear system. So, large number of reactions we will find that is based on this simple mononuclear compound. For the corresponding model studies, if we want to make some of these compounds; model iron compound – if you mimic the corresponding coordination sites, the coordination donor atoms. That particular simple mononuclear iron compound can show all these different types of

reactions, what we have identified as a corresponding dioxygenase behavior. So, it is a mononuclear system – mononuclear iron system. Already we have defined is a non-haem system. Going for the exact definition for the system; it should be a mononuclear non-haem iron enzyme.

So, basic classification and the basic difference between monooxygenase and dioxygenase is therefore, in your hand now. So, this iron… It can shuttle between again well-known oxidation states of ferrous and ferric. So, it can be Fe 2 or Fe 3 since the porphyrin in the big macrocyclic ring is absent; it is very easy to identify; that means all the donor groups, which are coming to bind those centers are originating from the protein chain or the protein amino acid residues. So, you can have nitrogen; you can have oxygen from the protein site chain. So, that protein site chain will go for this iron site. And, in these particular cases, they are high spin. So, that also people can identify by knowing the Mossbauer spectra and the corresponding oxidation state for these two oxidation states of plus 2 and plus 3.

There are also several groups of reactions. Those are basically catalyzed. One such is our typical definition based on that; which is extradiol cleaving. Extradiol – we are talking about something, where you have a diol system. Diol – we will just cleave that diol. One such diol we all know; that is the catechol. So, extradiol cleaving catechol. And, the reaction is the dioxy genase reaction. So, it would be extradiol cleaving catechol dioxygenase. There is not a single example of this dioxygenase. So, there are more examples of dioxygenases are there and this particular reaction. So, you have a substrate in your hand catechol and that catechol is also very easy to know that, we know that, the corresponding phenyl bearing amino acids in your hand; from the food material for any other substrate, you have the phenol bearing ring. If it is not at all a phenol bearing ring, it can be a benzene bearing ring. You can go for hydroxylation reaction; you can convert it from benzene to phenol.

Now, if you can go for, there are some groups, which are going for the transformation of the phenol to catechol. So, ultimately, you are converting it to catechol. But, what we are talking now; because we will be talking that also – how you can go from phenol to catechol. Now, in your hand, if catechol is there, how you basically cut the catechol molecule? Because you have to degrade; if you have the challenge, is that, the drug molecule or the steroid molecule.

Wherever you find aromatic ring, always you think that, by this mechanism, you can hydroxylate the thing; then, you can put the second oxygen; you make it a catechol unit. And, that catechol unit you can cleave it, because all the other biological important molecules, what we know – the different neurotransmitters; that we will see the neurotransmitters are all based on catechol molecules. But, they have some useful function. But, we are not breaking them, because that, if you break the molecules, it will be converted to some other molecules. So, the concentration of this useful catechol molecule will be less. So, one such is the catechol extradiol cleaving catechol dioxygenase; where, we go for this particular catechol molecule.

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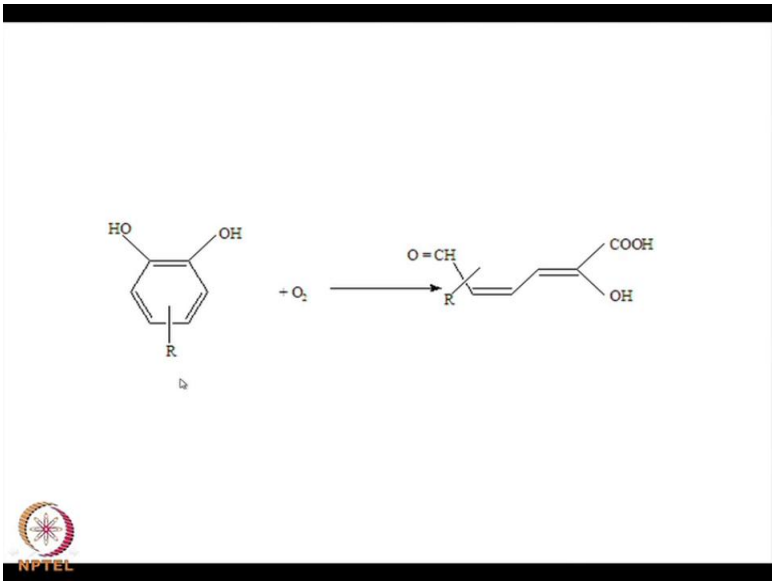

If you have the catechol molecule in your hand, there will be some connectivity for the different particular R groups. So, you have the R groups. And then, you put these two oxygen atoms. So, dioxygen molecule is getting inserted over there and you break the molecule. So, you break the entire molecule. And, that particular molecule what is there is basically we will be getting for the corresponding transformation. At one end, you have the aldehyde function; in another end, you have the corresponding acid function. So, you have… On the left, you see that, when you have the catechol, that catechol have 2 oxygen. And, on the right-hand side, you see a molecule bearing that oxygen, which are four in number. So, all 4 oxygens have been there; that means two from the catechol and two are coming from the dioxygen molecule. So, it is basically the cis, cis-muconic acid.

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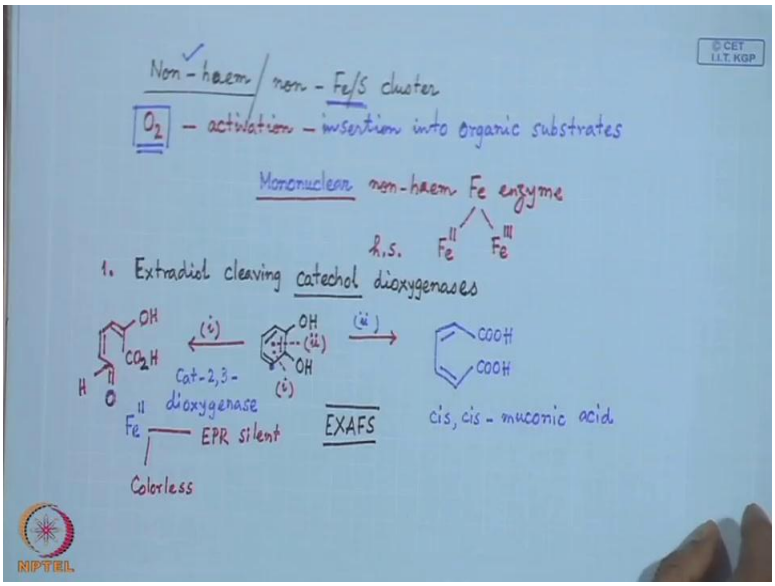

If we have… This is the catechol OH-OH. And, we want to cleave it. If we cleave it through this bond, we get a corresponding oxidative cleavage, which is extradiol in nature. So, this particular case… And, other would be a different one, which is this one. So, which is extra and which is intra? This one is extra and other one is the intra diol. So, these two are the typical positions what we can basically cut. So, we are basically cutting the C-C bond. And, in this particular case… So, this is 1 and this is 2. If we just go for the reaction 1, we should be able to write the product, what just now, I have shown in the screen. This is the aldehyde; this is the O H, and this is the CO 2 H. So, this I have shown you.

This particular one involving a center, which is iron center, mononuclear one; and, which is involving the ferrous iron. This ferrous iron center can very easily be identified for this reaction. And, this reaction therefore, if we just consider is 1, 2, 3; the numbering is – this is 1; this is 2; and, this is 3 for the catechol. So, 1, 2 hydroxy benzene is the catechol. So, it is the catechol 2, 3 dioxygenase also. So, this particular one – the catechol dioxygenase in this form – if it is a ferrous center involving there; which will be colorless. And, if you go for electron paramagnetic resonance; which will be EPR silent.

In this particular case, when you write… or this particular transformation reaction; that means you are just basically consuming both the two oxygen atoms. So, one such oxygen atom, how it is going? One such oxygen atom from the air is this oxygen. And, another

one is the corresponding second oxygen of the carboxy function. So, we just (( )) this 2. So, this is the second oxygen of this carboxian and another one, because we are cleaving this particular part.

So, catechol 2, 3 dioxygenase reaction. And, number 2 is… So, this is the extradiol cleavage. And, number 2 will be inside; that means C-C bond bearing the hydroxy function. From there, basically, we will be getting… which is cis, cis-muconic acid. So, these two products basically are different. How we go for this particular reaction for these two different types of product? One is the extradiol one and another is the intradiol one. So, not only the color, that means, the UV-visible spectra; but also, sometimes, the extended X-ray absorption fine structure spectroscopy also.

X-rays are also useful to find out the corresponding monodentate function for this center, because this particular one when you have some site, that it binds initially, because the catechol through this oxygen is a very good ligand. So, initially, depending upon the pH of the medium, it can go for the deprotonation. And, it go through one oxygen. And, in the second step, it can go for binding through the second oxygen. So, it can function as a bidentate ligand at the same time. So, if you have a mononuclear system; and, the mononuclear system should have certain vacancies; that means at least, it should have two vacancies such that the catechol unit can go and bind to that mononuclear system in bidentate fashion. So, these two oxygen center can go and bind to that iron site; and then, this particular iron site is involving there for their corresponding cleavage reaction.

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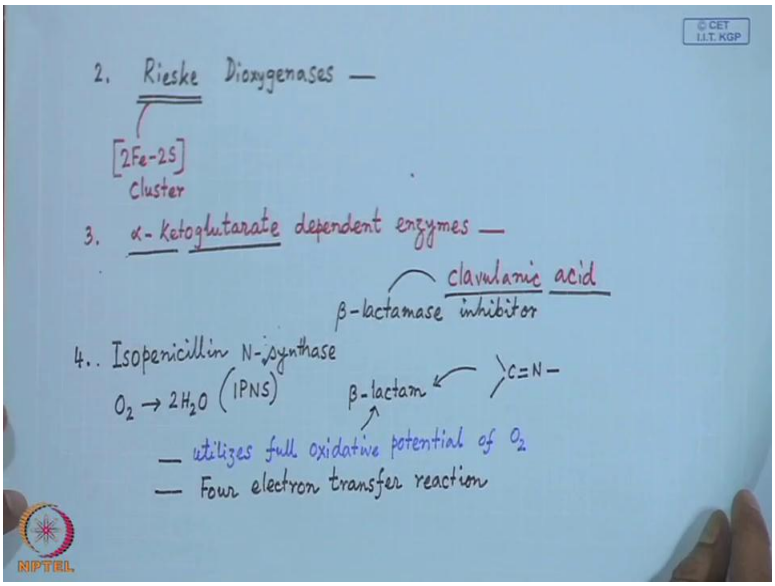

The second reaction utilizing this particular catalytic site is rieske dioxygenases. So, rieske nomenclature – we know that, a rieske center is therefore, iron sulphur system. So, that iron sulphur is not a 4 iron-4 sulphur system, but is a 2 iron-2 sulphur cluster. So, it also contains a 2 iron-2 sulphur cluster. Nearby, you have a corresponding mononuclear site, which is responsible for the corresponding dioxygenase reaction. Here we will see that… Now, you can take the corresponding benzene ring itself.

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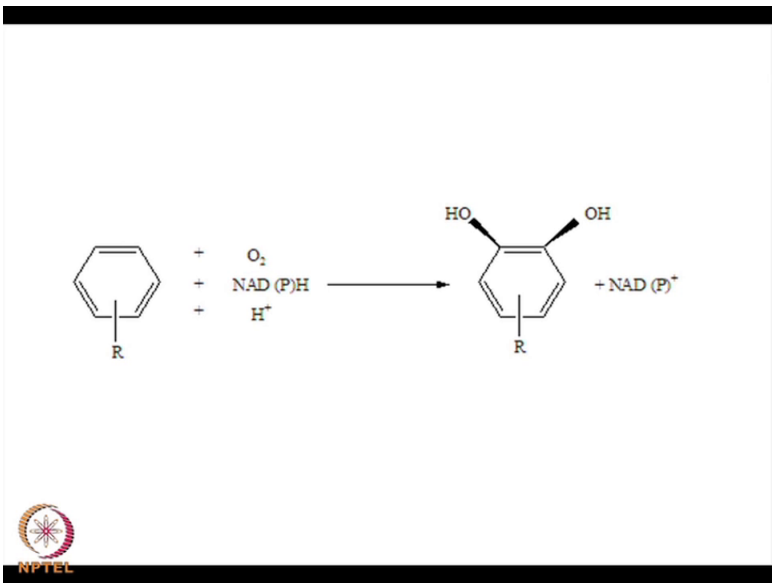

That ring basically gives us the corresponding reaction in a single step. Just now, we are talking about that you can convert for a reaction utilizing the monooxygenase. So, that monooxygenase reaction you can go for this particular group; that means the mono oxygenase reaction – if it is utilizing on benzene ring, it can go for a single oxygen atom hydroxylation reaction converting it to phenol. But, this rieske dioxygenase reaction is a very straightforward reaction; that means utilizing the dioxygen. And, again we will take the help of NAD P H.

So, the biological reducing agent we require. And, this biological reducing agent is required for the corresponding reduction of the center, that means, the iron center. So, you reduce this, where particular iron center and we also utilize the proton. So, one is coming from this NAD P H; and, another proton is coming from this converting this into a catechol unit. And, this hydroxylation reaction – this bonds you see – this OH and OH on the same side. So, is a cis-dihydroxylation reaction. So, this particular cis-dihydroxylation reaction can take place very nicely involving that particular iron site, which is a mononuclear one. Then, you have the next category of reaction, which is little bit complicated by name; which is alpha-ketoglutarate; that means alpha ketoglutaric acid we are talking – alpha-ketogultarate dependent enzymes. These are very useful reactions.

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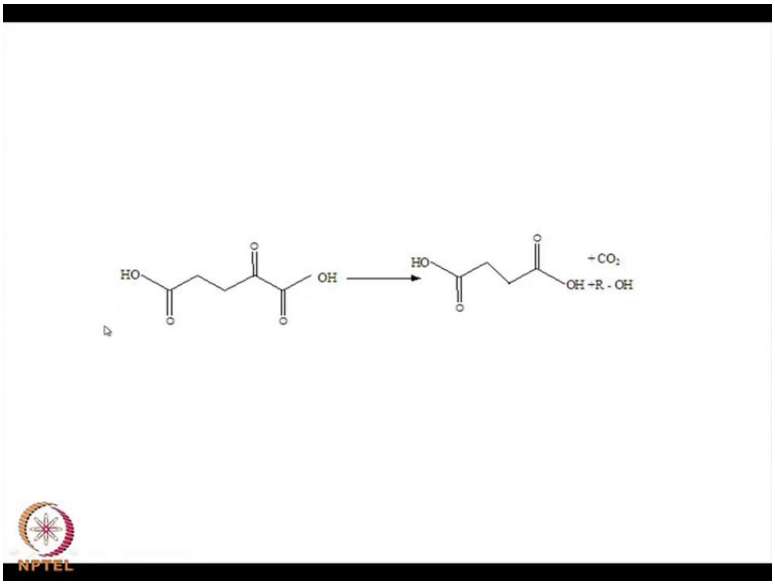

If you have alpha-ketoglutaric type of molecule, what we get that, this is the alpha-ketoglutaric acid. And, involving the dioxygen here over the arrow, you will have the dioxygen molecule. And, that dioxygen molecule is utilized for the conversion of some species, where the oxygen group is going away and one of the carbon center is utilizing for giving rise to the carbon dioxide and some R-OH; it means it can be the water molecule also. So, basic reaction for this is that, this keto function. This keto function is basically going away.

And, this keto function for this particular transformation is not that both the oxygen atom is getting inserted within the molecule, because you are cleaving. So, one of the oxygen is getting inserted within this molecule; which is what? This is the succinic acid. So, it is getting into the succinic acid. And, you have the carbon dioxide. And, this particular shortened group, what we get; that means the shortening of this corresponding keto acid is very important for some important reactions like for antibiotic resistance, for clavulanic acid. So, that clavulanic acid synthesis, which is very useful for the corresponding antibiotic action, because they are related molecules and all these; they can block the corresponding clavaminate synthase. And, antibiotic resistance – we are coming for that corresponding beta-lactamase inhibitor.

And, nowadays, some antibiotics when prescribed is given along with this clavulanic acid. If you can convert in this fashion, that means, you can generate some of these useful acid in our body through this dioxygenase reaction, because this particular reaction based on this iron for this dioxygenase reaction is very important when we talk about this beta-lactamase or the penicillin group of molecule. For some synthesis of penicillin molecule – for isopenicillin N-synthase known as IPNS – isopenicillin N-synthase – in this particular case, we go for simple reaction; that means penicillin synthesis we know that, we should have a beta-lactam ring. And, that beta-lactam ring can be prepared in several ways. You should read little bit of these as well that, how the beta-lactam ring is formed immediately, because this beta-lactam ring can very easily be formed from a well-known functional group, is the immune function; that means the corresponding cis bases.

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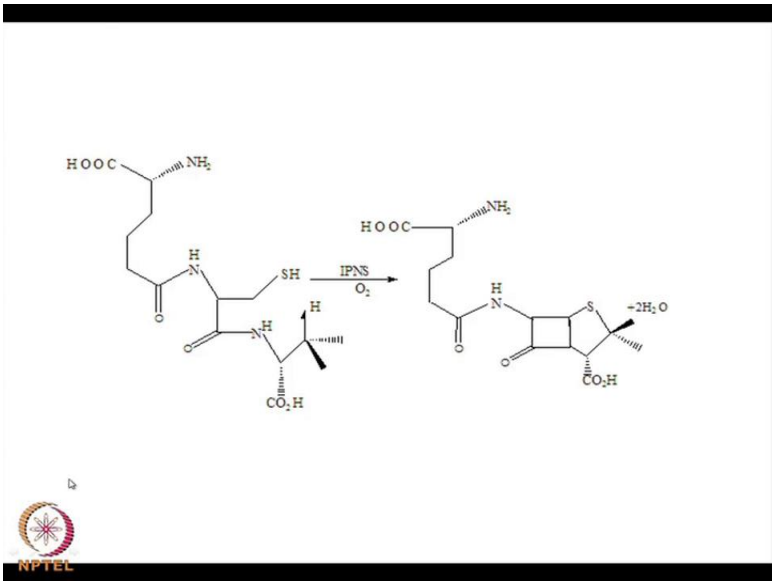

This beta-lactam when it is forming, this group is basically required for the corresponding cyclization reaction like this; that means when we go for the cyclic unit; that means if you have this entire ring, only this part is not there. So, this cyclization reaction – it is CH 2 and it is NH. So, this particular one – CH 2-NH – when it is there; and, this particular one – you have the corresponding N is there, is missing. Therefore, this N is there; here you have N. So, the ring formation… So, basic idea behind this is that, how we can go for this simple reaction. We are talking about this corresponding oxygenase reaction.

And, that oxygenase reaction when we are going from one step to the other; we also can be utilized in presence of this dioxygenase, the typical cyclization reaction. So, it is not that you are inserting the dioxygen into the system, but it is one fashion, it is also a dioxygenase reaction, because the utilization of this dioxygen molecule – that particular dioxygen molecule when we are giving into the system; that it is producing two water molecules along with. So, these two oxygen atoms, what we are looking for that, this oxygen is getting inserted in a complex molecule.

But, in this particular case, since we are talking for a cyclization of beta-lactam ring, it is required for this cyclization reaction. And, this cyclization is basically useful for the corresponding reaction; that means this – you have this sulphur this thing and this four membered ring also. So, both the four-membered and this five-membered rings are

formed. And, it is the final step for this beta-lactam ring formation. And, we know that, this is a typical example for a heterocyclic ring also. So, this particular reaction is also useful for giving a corresponding heterocyclic ring formation reaction, where we are basically utilizing the full oxidation potential of the dioxygen molecule. So, in this particular case, we will be getting a complete cyclization of the corresponding heterocyclic ring, which is the beta-lactam ring.

And, that beta-lactam ring basically, in this particular case, when you are consuming the O 2 molecule; and, that O 2 molecule is converting to 2 water. And, all of them are living as water following the cyclization reaction. Therefore, this particular reaction utilizes full oxidative potential of the entire O 2 molecules. It is utilizing the potential; that means you have this oxygen. So, as we have seen in case of cytochrome c oxidase, it is therefore, a four electron transfer reaction. When we are just simply consuming this O 2 and forming the corresponding water molecules; and, we are getting the corresponding final step for the cyclization reaction for the beta lactam synthesis. So, that is why, it is known as isopenicillin N-synthase. So, this particular reaction therefore, is iron dependent typically and the dioxygenase reaction.

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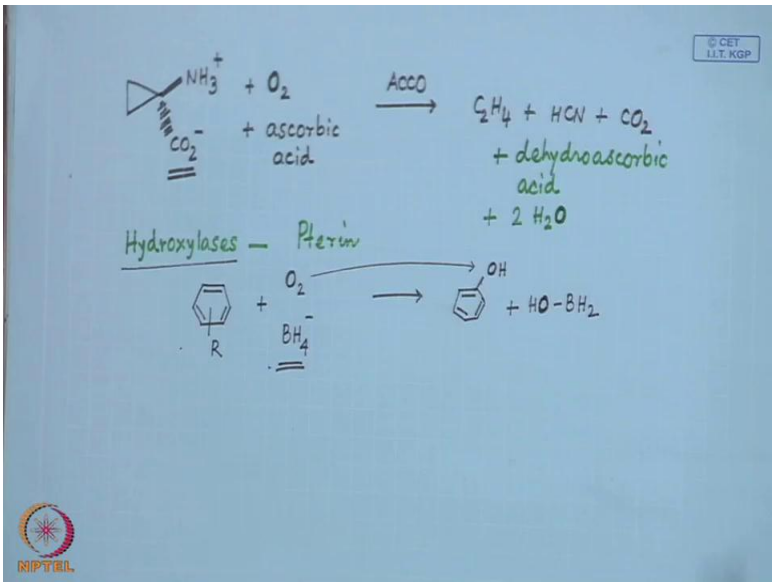

There are some small reactions utilizing other oxidase reaction. If we have a substrate like this like NH 3 plus, CO 2 minus; this will be trying to see the corresponding reaction with O 2 as dioxygenase. So, we have… The O 2 is available for its corresponding

dioxygenase activity in presence of some reducing agent, which is the ascorbic acid. The center is known as, is a big name based on the substrate, because most of these enzymatic reactions – we term as a corresponding substrate. When it is acting on penicillin, it is the penicillin synthase; when it is the clavaminate synthase, it is acting on the clavaminate. So, they are very specific reactions. But, our idea to know that, if you have a typical this sort of substrate, that means only this NH; here we say backbone is typically a corresponding amino acid backbone.

If we have a similar amino acid type of zwitterionic form, how it can react with that of these dioxygenase molecule in presence of some reducing agent? Basically, these molecules are present in plants. Plants – we know for food ripening and all these, they produce ethylene. When you get this basically, converting this from this background from this cyclo-porphyrin ring; from this cyclo-porphyrin ring, it is forming a molecule of C 2 H 4 – a molecule of ethylene is formed plus HCN. You see how this thing reaction is going for this (( )) a biology. Then, CO 2 is forming also. CO 2 is nothing but from the decarboxylation reaction. So, all sorts of reactions are taking place together – the ethylene formation, the decarboxylation producing CO 2, and this ascorbic acid is getting reduced to dehydro one to dehydroascorbic acid plus 2 H 2 O.

And here also, this O 2, that means, these 2 oxygen is consumed over here. So, oxygen is again utilizing the four electron transfer to produce two molecules of water. So, these reactions basically are useful not only for this type of reaction, that means, the corresponding elimination reaction. But, also, some of these reactions we can consider is as hydroxylases; that means the hydroxylation reaction utilizing dioxygenases – hydroxylases. So far, we have seen in case of monooxygenases; that means one single oxygen is utilized for this corresponding reaction.

So, this biological cofactors are utilized there. And therefore, several biological cofactors like pterin or tetrahydro bi–pterin – all they are the corresponding cofactor, which can function as a corresponding NADH. And, if you have the substrate; that means the same aromatic ring if you can have with R; and now, remember it that, now, we are utilizing a dioxygenase. That will be utilizing this O 2. But, the function for this pterin or anything else – that can also be compared if you have a polyhydride type of anion also. So, this can go for simple insertion of one oxygen atom; that means you are going for corresponding hydroxylation reaction, not catechol formation.

So, this is a special type of reaction, because utilizing dioxygenases; and, we get the corresponding simple one oxygen atom insertion reaction; that means the corresponding hydroxylation reaction. So, one of these oxygens is coming from this; and, another will be taken out by the reducing agent, which is say OH-BH 2 or any such kind. So, this oxygen is another oxygen is taken out by the reducing agent. So, these sort of reactions utilizing these dioxygenases are very important, because we have or we use large number of amino acids.

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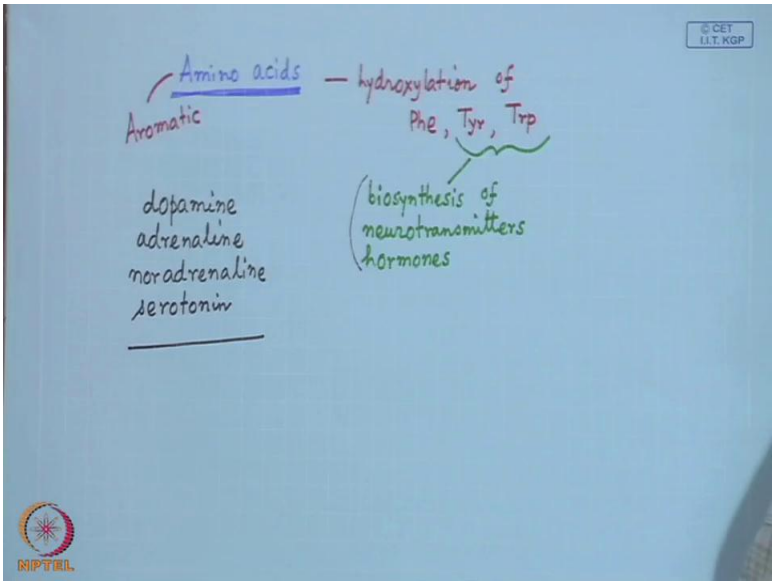

We have large number of amino acids as a source for the different important biomolecule synthesis. If we have some amino acids; and, these amino acids, what we are not utilizing like this plant; that means you just simply go for ethylene elimination. But, these amino acids bearing phenyl groups; that means you have the amino acids, which are having some aromatic rings. So, amino acids bearing these aromatic rings and they are there like that of the peptide chain and all of other substrates. So, anywhere you get the corresponding amino acid with a pendent or a hanging phenyl ring. So, that phenyl ring can go for typical hydroxylation reaction. So, we will be knowing… By knowing all these that, it can go for hydroxylation of all phenyl ring bearing amino acids; that means phenylalanine, then tyrosine and tryptophan.

This therefore, tells us immediately that, in some cases, because we know there are several other groups of molecules; we will be studying afterwards that copper bearing

hydroxylating agents. They are known as tyrosinases; that means they are utilizing for age reaction; that means it can be monooxygenase or dioxygenase reaction. But, the substrate is tyrosine.

When the substrate is tyrosine, its activity is tyrosinase. But, in this case, these iron-bearing dioxygenase molecules, are also being utilized for hydroxylation reactions of these phenylalanine, tyrosine and tryptophan bearing groups, because they are very much useful for some of our very important chemicals; that means they are involved in biosynthesis of neurotransmitters as well as different hormones.

Whenever now onwards, you find something that some pendent ring is there, then amino acid site chain is available; and, that amino acid site chain bearing this particular phenyl ring; and, which are having some either one OH function or a catechol like double OH function, you will always think that, on the last step, where you just insert this oxygen, this dioxygen can be inserted from the oxygen available from the air. So, dioxygen molecule can be utilized for the generation of these very important molecules, because these neurotransmitters are very important, because the deficiencies lead to some of these several diseases.

So, these molecules, what we know that; therefore, the synthesis of, is a vital step involving these dioxygenases is therefore, for the synthesis of dopamine, which is a neurotransmitter. So, the dopamine molecule bearing this carbon hydro oxygen bond, that means, the hydroxylated unit. So, that hydroxylated unit is going through this dioxygenases; then, adrenaline or nor adrenaline; and sometime, for maintaining the level of serotonin. So, for all these molecules, the important step for, is that you have a mononuclear iron site; and, that mono nuclear iron site will be utilized for the corresponding hydroxylated form.

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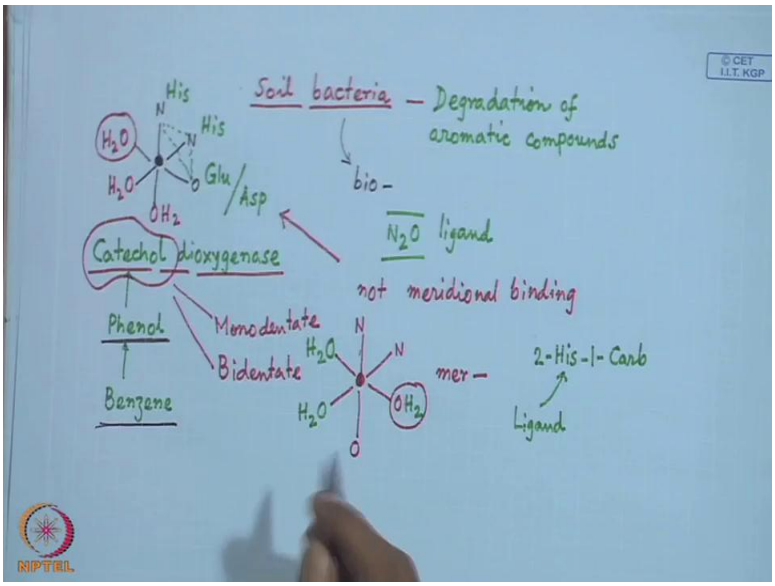

How these hydroxylated form we can get? That if you have a system; that means if you have a center; and, just now, we have seen that and we have identified it as, it is a mononuclear iron site. So, definitely, it will be a corresponding octahedral site. And, if we just simply take the example for catechol dioxygenase; you have the catechol; that means this catechol we are getting from say phenol or some benzene unit; and then, ultimately, we see that, this particular catechol can also be cleaved. So, these particular reactions – all these sequence of reactions are very useful for some molecules, which are there, which are present; in some cases, it is present also in soil. So, the soil has some bacteria. If we can find that from the soil bacteria; that means the soil bacteria will have the catechol dioxygenase.

And, that catechol dioxygenase – once it is making the catechol and then catechol is going for the cleavage reaction. So, basically, what we are getting; we are getting the degradation of aromatic compound. So, most important thing is that, we are basically degrading – degradation of aromatic compounds. So, this particular soil bacterium, which is containing this catechol dioxygenase, can go for some degradation. So, if it is the degradation; that means you can just break molecule one after another.

So, you basically, once you start from benzene or phenol, you can degrade the entire benzene molecule or benzene part or the phenyl part. So, basically we can say it as a biodegradation process. So, this can be considered as a typical biodegradation process of

catechol molecule, because sometimes, if we have the nature, the environment accumulates large amount of these (( )) molecules. These are all deadly the benzene, phenol and the catechol. But if we are unable to break down them; if you are unable to degrade them, they will pile up in the environment. So, both these extradiol and intradiol cleaving agents; that means the iron based – these extradiol and intradiol cleaving agents are useful for this particular degradation reaction.

And, we have the mono nuclear system. And, this mono nuclear system – we just from the corresponding protein site chain. This protein side chain will provide you the histidine nitrogen, another histidine nitrogen and oxygen from the acidant; that means it can be from the glutamate or it can be from aspartate or any other carboxyant. So, something you get; that means you are getting something at a tridentate ligand N 2 O type. So, you have in your hand N 2 O, not as a nitrous oxide, but N 2 O ligand. We write in this fashion – N 2 O ligand. Two of the nitrogen donors are coming from histidine residues and one from the corresponding glutamate or aspartate residues. So, this particular one; and, we just occupy a particular face of the octahedron, which is very important. So, this particular face is very important.

So, facial binding of this is not a meridional binding. Why? Because we will find that, for meridional binding, the available other positions; because for facial binding, you have the free positions. So, availability of three facial positions of water molecules, are therefore, important. So, you can say that… No; this if you have a meridional binding; like the same iron site, if you just change to a meridional binding, this would be N, this is N. Now, instead of this oxygen, this will be the oxygen. So, this is meridional binding. So, if you just go for this meridional binding, the available sites… This is not meridional binding; do not confuse it. This is meridional binding.

Available water molecules, the position of those water molecules, are different now. So, this particular combination of this; that means either it is in the facial form or in the meridional form, the ligand, which is N 2 O type ligand or the biologists or the biochemists do like to write in this fashion is 2 histidine 1 carboxylate ligand. This is their nomenclature for ligand. So, you have 2 histidine. So, the ligand is 2 histidine and 1 carboxylate. So, we will be… We are talking… So, the detail mechanism we will see in our next class. And, that detail mechanism will tell you that, this particular orientation is important and it has been confirmed there, because if you have these three facially

oriented water molecules and you are talking with something, which is nothing but the catechol unit. In your mind, immediately, it can come to you that, you have catechol; this catechol can function as a monodentate ligand to the iron site or it can function as a bidentate ligand.

Why we require these particular three sites? That means binding through single oxygen – single catechol oxygen to the iron site or the binding by two of the oxygens of the catechol unit to the iron site is therefore, important. And, these two sites, which is also possible to have for the meridional environment, but this particular site, that means, the third site. When these two sites are occupied, that means, this third site; and, in this particular third site, the position of these two third sites are different; that means the positioning of this particular third site is important to get the corresponding reactivity; that means instead of this water, if you have water over here, you have a one type of reactivity. So, all these molecules not only for this particular catechol dioxygenase molecule, but for the different types of synthetic molecules, what we can have that, binding of this bidentate and the tridentate one is very important.

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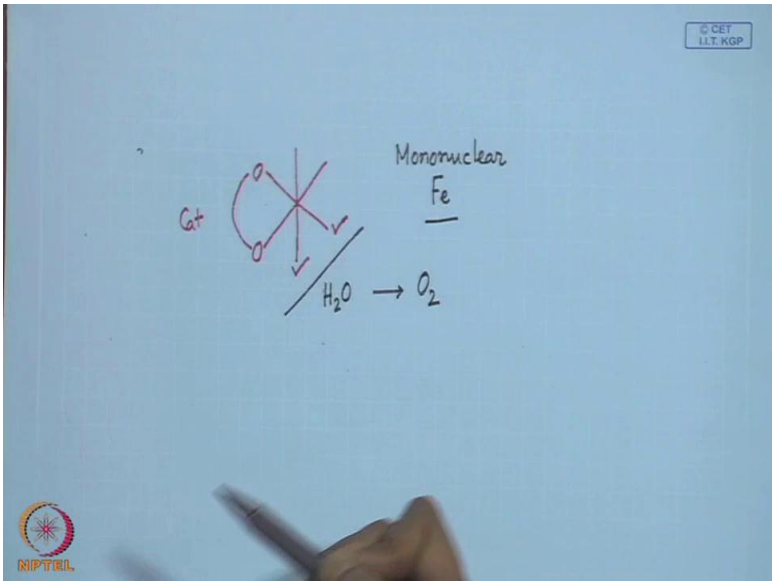

And, when we see that, this particular one; like we have seen the fifth coordination site is so important that this particular oxygen of the catechol and this oxygen of the catechol. So, you have… If you just… This is the catechol binding. So, the positioning of the next group; that means whether you have water over here or whether you have water over

here, makes situation different. But in all these cases, why we require this? Because we are dealing with some system, which is very simple one, which is mononuclear one, which we are talking about the mononuclear iron site is a very simple one, not a very complicated one like the other binuclear or any other system. So, you have some position for substrate binding and some position, which is available for the water molecule; that is in the same fashion, will occupy by the O 2 – the incoming O 2 molecule, which will be responsible for the dioxygenase activity. So, the positioning of this O 2 is therefore, important.

Like the haem proteins, the positioning of this dioxygen in the sixth coordination site was important; similarly, positioning of these. So, not only these metal center; important thing is that, you should know the positioning of the metal center and how close the substrate is as well as the reagent, because the catalytic site is this – iron site. You have some of the ligating groups. And, those ligating groups are holding the metals site.

And then, what you are bringing? You are doing altogether; like in the test tube or reaction vessel that, you are bringing the substrate; it can be the benzene ring; it can be phenol or catechol; as well as, you are bringing the reagent. So, these positions – either this one or that one, will be occupied by the reagent. Then, the reagent will attack the substrate molecule to go for the reaction. So, the positioning of these reagents with respect to the substrate is important; whether it is occupying the meridional position or it is occupying the facial position. That we will see in our next class, when we go for the detail mechanism.

Thank you.