Heterocyclic Chemistry
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Lecture - 40
Heterocyclic Rearrangements

Good afternoon, today's topic is Heterocyclic Rearrangements is a kind of topic not covered in one single heading. And I had to collect from different places; different rearrangement reactions of course, all of us know rearrangement means, basically the molecular rearrangements. The molecular skeletons undergo rearrangements and in my list there are about 10 different rearrangements. But today I will be only covering 7 rearrangements. Well, out of this 7 for the first one has already be talked in one of the earlier classes.

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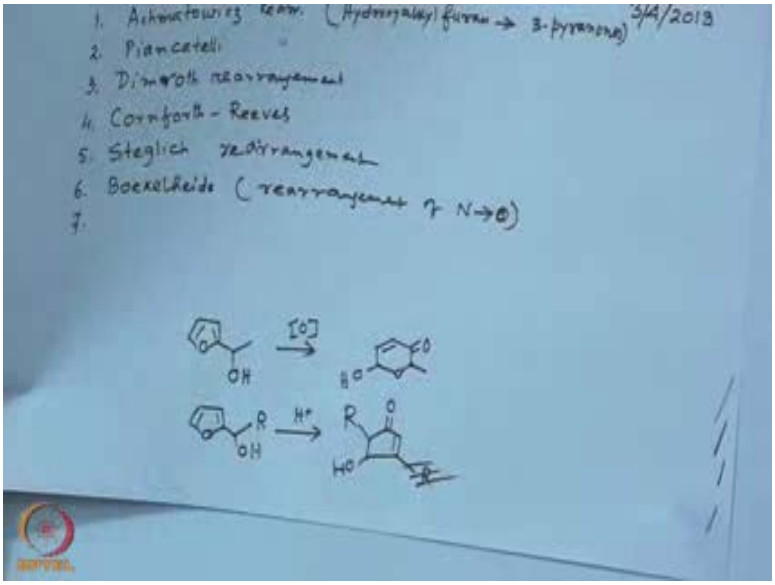

If you remember that was the reaction called Achmatowicz reaction right. Achmatowicz reaction and what is it? It is an Achmatowicz rearrangement right. And it is a reaction of hydroxyalkyl furan derivative, furans to what? 3, pyranones right. And actually it is a 6 hydroxyl 3 pyranone. If you see try to recall it is something like this, it will have a hydroxyl at the side chain at the 2 positions. Then you have to do and mind it oxidative kind of reagent either beta chloro for benzoic acid or tertiary butyl hydro peroxide or in this methanol all these things eventually what you will be getting you will be getting 3

pyrrole means, oxygen with respect to this is carbonyl. Then, and easy to remember though what is it remember? Then you have an alpha, beta unsaturated system and the final one H O occupied by this.

Today will be talking about a very similar reaction this is known as piancatelli rearrangement. Piancatalli rearrangement is very similar to the Achmatowicz reaction we will see may be you can write here. It is a something like this, quite similar though quite similar. And let us say if you have a R up here and 1 of the presence of acid dilute acid of course, dilute acid guess anybody knows what is the product? The product is a cyclopentene derivative. And this R group is at 3 position and then O H group at 4 positions. This is 4-hydroxycyclopentanone this 2 different contrasting reaction. But if you see here the structure is very similar to the previous one but in this case I think this should be methyl group here and Achmatowicz reaction here ok.

And, the 3rd one I will talk about a quite famous this is known as Dimroth rearrangement. The dimroth rearrangement that I will talk about then, this is a very pretty interesting reaction all again corn forth rearrangements. I have named it is corn forth and reeves because reeves have contributed quietly top chemistry to this rearrangements. Then there is a pretty simple chemistry call steglich rearrangements. And probably I will stop this one ok. Then probably well I think will stop probably here, one more reagent called boekel Reid. And boekel Reid rearrangement and which also pretty similar to polar basic reagent. And basically deals with rearrangements of aromatic N-oxides under this category then there are other things like ((Refer Time: 05:27)) rearrangement many of you probably and then ((Refer Time: 05:31))

Then those are not really directly related to the heterocyclic chemistry in principle, if you have studied any rearrangement in the carbocyclic chemistry that can be applied to the heterocyclic chemistry. I am not considering those reagent arrangement if you just do on a heterocyclic nucleus you will end up in a heterocyclic molecule I am not talking about that. Let us say 2 the biotic reaction the biotic rearrangement those are the reactions known for the elliptic systems or non heterocyclic systems. So, any case we will look at this since, Achmatowicz has been covered before.

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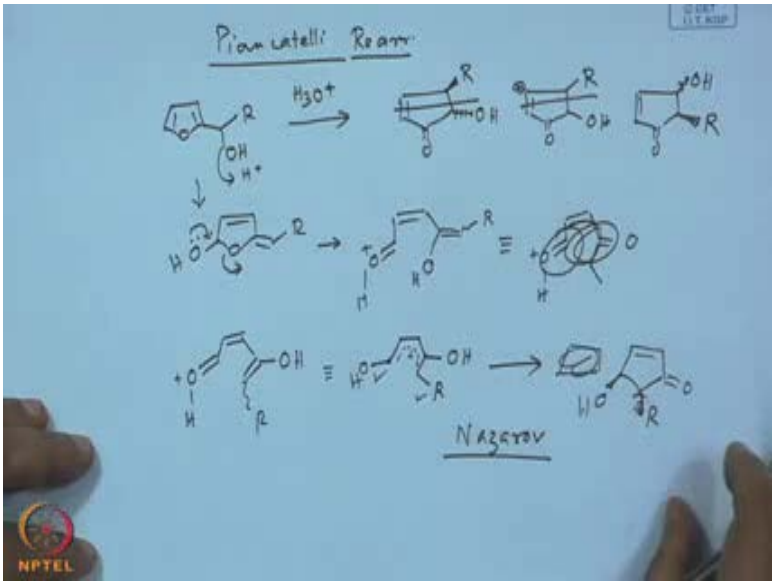

So, let us take a piancatalli reaction. Piancatalli is already been told so what you have to find out? You have to find out the reaction mechanism the starting material is so is this hydroxyalkyl furan. And the reagent also you have to remember it is just in a dilute acid and so; I am just rewriting. So, it is a cyclopentanone and R and then this hydroxyl here by the by you have to take up this stereo chemistry. This stereo chemistry now, is sorry mistake right this step this is 30 minute it should be I think should be hydroxyl here. And R or this mistake I think somewhere we have made a mistake we will go we will see this once we see this mechanism. Probably I think it would be clear apparently R is here and this hydroxide here. So, 4 hydroxyl 1, 2, 3, 4, hydroxyl,5 alkyl mind it this tree chemistry here is a Trans to each other I think well we are right.

Let us see let us look at this mechanism what is the possible mechanism in the presence of acetic water? So, O H would be added to this one then because it a presence of water, this loss of water would dearomatize the system. And what you will get this hemiacetal kind of thing right hemiacetal. And then again further all of us know hemiacetal breaks open and what you will be getting you will be getting an oxonium ion and double bond here. Then you can sis this oxygen of course, would be protonated and so then you have this R here ok. And mind it this is pretty similar though it is you will see here, you have carbonyl, double bond and this is what? This is again this is carbonyl here right. I think what I will do here, let me just rewrite oxygen hydrogen plus. And double bond of here

and you can rewrite this way, this is R and this is right. This second carbon is oxygen and this right ok.

So, again this could be rewritten as O H and then this then this. And the positive charge is now, this paired with this one. Now, what is it? It is a 4 electron cationic system means, you would expect a reaction name reaction what is it? 4, 5 electron system and it is a cyclizition process. So, 4, 5 electron cyclizition thermally what is it is conrotatory and disrotatory?

Student: conrotatory.

So, conrotatory means conrotatory means if you have two groups like this then it will be Trans to each other and that is this hydroxyl. And this one would be sorry this R here, this O H this would be R this would be O H this is Trans right. The other one of course, if you just a do the electron balancing it would be alpha, beta unsaturated ketone. And what is the name of the reactions? Anybody, remember this pretty well known reaction though 4, 5 electron cationic system cyclizition reading to cyclo pentanone yes, yes right. So, it is a basically Nazarov reaction. So that means; a furan you are going to get the that means, you will just to have to make a small corrections here, the correction should be R should be here right R should be in the 5 position ok.

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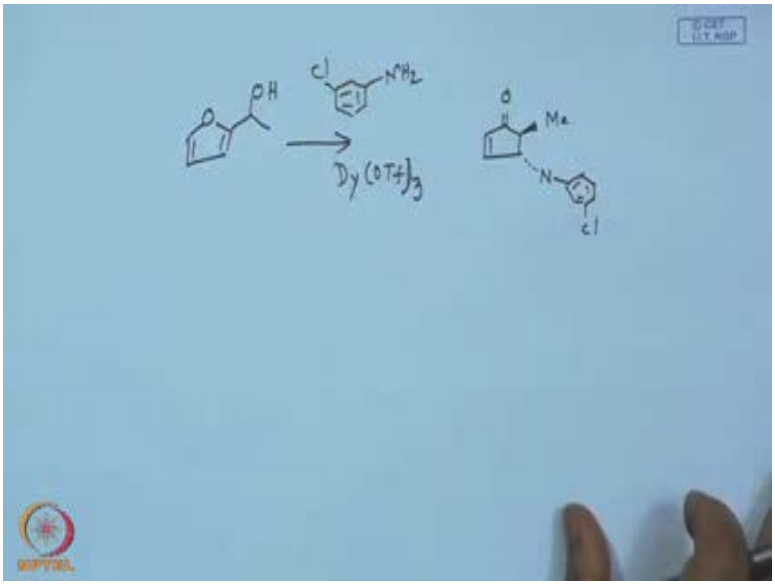

So, this reactions has been extended too many many systems for example, very recently in 2010 same reactions has been carried out with the substrate of the with methyl group. And the side chain hydroxyl at the side chain and this without water. So, you are basically using an amine and then example particularly one this then dysprosium is D Y is the triplet. So, it is a non aqueous medium. So, what you will be getting so you can just bind a write the cyclo pentanone. And R in this methyl and the disposition is Trans know in the place of O H. So, you can expect an amine. So, this was done that means; what you can say, you say aza T N catalyst reactions rearrangements.

So, like this there are other examples you can do also the intra molecular version. And if you have an inbuilt O H group there instead of this water adding to this carbo cation one can expect to addition of this one. And I think we will not talk much about the other examples here.

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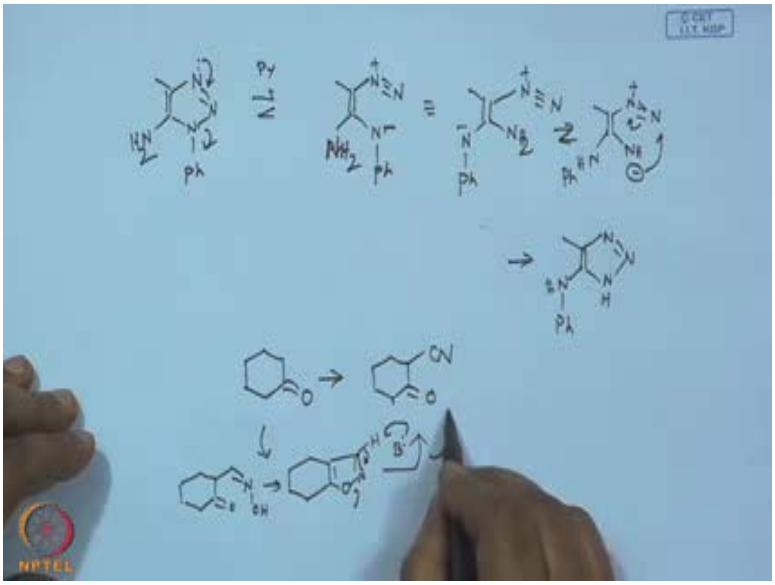

Let us look at the one more important reactions such pretty famous reaction actually in heterocyclic chemistry that is dimroth sorry that is dimroth rearrangement what is it? It is a basically amine substituted. So, you can say amino hetero cycles getting converted to amino hetero cycles. For example, I think if you taken amino pyrimidine here, amino pyrimidine. Then you will treat with this ethyl iodide of course, it is very difficult to out of the 3 nitrogens it is a very difficult to point out which one is more nucleophilic in nature right. This more nucleophilic in nature which one you think. And between the 2

pyrimidine nitrogens both the nitrogens of pyrimidines are equivalent right. So that means; only to competition between either of this ring nitrogen or the external nitrogen in most cases the ring nitrogen is because electron is pool towards the aromatic ring system ok.

So, this reaction would give you this initially this N ethyl derivative then it

tautomerizes to corresponding imine and this so; basically this amino pyrimidine. Then if you treat with this sodium hydroxide you will end up in there is a dislocation or i should say Trans location of the nitrogen. So, eventually you will be getting N H ethyl group here. So, compare the basically what is this dimroth rearrangement? Dimroth rearrangement is this A getting converted to B, A getting converted this is basically the dimroth rearrangement. What is the change you see here that this ethyl group is located at this ring nitrogen. Now, it is relocated in to this side chain nitrogen so that is; the almost all of these dimroth rearrangements eventual product is the amine with the alkyl side chain or whatever the side chains are available that would be finally, located in to the side chains ok.

And, what is the mechanism this mechanism wise if you think about this in presence of water. So, it would be basically water adding to this nitrogen here I guess let us say nitrogen. Then we will have double bond N H and this is N H here and then this basically just one- fourth water addition. Then what happens? Presence of this base again this undergoes ring cleavage. So, you will be getting this I can say I in fact did I make any mistake I think instead of writing this. I think you can just it would be easier if you just break open here. So, you will aldehyde the double bond then nitrogen and this there amine form and this is now; N H and ethyl here. So, this is I mean if you just this is equivalent to this aldehyde double bond N H. And then just basically rotate this terminus. So, it will be N H ethyl here, this is now; amine right. And then as usual the driving force is again just what you will be getting, you will be getting again very similar to the one of the previous intermediates.

And, so; this should be N H and N H here and double bond right and just the reverse kind of thing. So, reverse kind of thing and then if you can think of right loss of water so the product would be this pyrimidine of course, and now this side chain is ethylated. So, initially the ethyl group was placed as in the ring nitrogen now, at the side chain. So,

what is the summary? What is the main feature of this dimroth rearrangement? Basically, ring opening. And the cyclizition recyclizition this is a common actually phenomena in heterocyclic chemistry whenever, there is a possibility it will move towards the most thermal aromic or more thermal aromic product ok. Let me take you to 1 more example, also it is true for I think it is true for 5 member ring. I think I will not give you the examples, let us say may be you can take care of 5 member ring first if you have a Triazole see here is a phenyl.

Now, the side chain you have a pyrimidine and then R. Now, in the presence of even just dissolving in pyridine you can expect a reaction. So, what is the possible reaction here? In the previous case it was alkyl right in this case there is no driving force just basically the polar solvent. So, it assume to the in equilibrium with a jutrian of the iso dipole ion of this kind. So, here N H, N minus pyridine and which is equivalent sorry this is N H 2 this is equivalent to that means; just rotate this N H 2 here nitrogen plus. And now; this is what? This is N P h right N P h. And all of you can understand that this proton can undergo internal transfer making this nitrogen N H or this nitrogen negative. So, it can be in equilibrium with so; these are all this is simple mechanism. So, you can think about this N H P h here and then recycle this.

So, recyclization this is again, that means; you starting from heterocycle triazole you again and you have with an heterocycle which is triazole. And the other side chain now, is P h so ring opening ring closing. So, these are all there are other examples it will more complicated cases. So, but essence is same that you just if you have a driving force for the reopening you can get to this for a just. Let me just mention one more very similar kind of rearrangement it is not exactly the dimroth rearrangement. For example, if you are to make let us say compound of this kind cyclohexanone and 2 alpha dynamo ketone how do you make it?

I mean, there are so many O H to make if you try to let us say do a chlorination here, bromination here. Then displace cyanide no there is that is not a very simple state call ((Refer Time: 23:18)) now. Because all of us know cyanide will form cyanohydrins there are other complication cyano also can induce the elimination process. So, one of this ways to overcome this sort of thing is to make a compound of this from the corresponding oxine right. If you have oxine here you can cyclise to the corresponding what oxazole, isoxazole? Now, if you treat this with a strong base see it is unlike just

strong base it just opens out that means a base would pickup this proton here. It will cleave the cyclo this isoxazole ring systems corresponding this is just what i am saying it is not a ring closer just ring opening reactions. And this is only specifically ment for the isoxazole cases ok.

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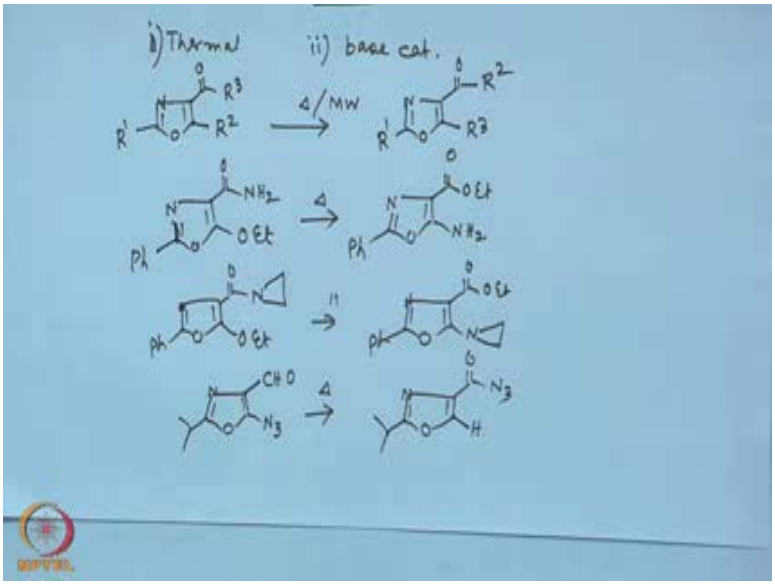

And, let us now go to another very interesting rearrangement that is known as one- forth many of you have heard of this name write this is before Cornforth. Now, Cornforth is a nobler he exclusively work on biosynthesis also he work on synthesis. And but in this case I will also give the credit to one more young scientist call reeves he was contributed quite a bit to this corn forth rearrangement. What is it? It is a there are actually, there are 2 kinds of rearrangement 1 is thermal the other is base catalyzed actually base catalyzed reactions. Thermal one again it involves only the oxazoles and with a substituent at 4and 5 positions. Let us say if it is R 1, R 2 and R 3you see here just heat or even M W right M W, so; what it is? Anybody, knows

Student: microwave.

Microwave so what will see here there is a big change and noticeable change there has what you see? You see 1, 2, 3 that means; there is interchange of the alkyl group here or some groups here. Let me tell you this specific example, I think that would again you draw N oxazole system and see this is immaterial almost. So, I will write phenyl here do this heating and what you expect? That means; this ring skeleton is unchanged this

portion is unchanged then 2 position is unchanged. So, 1, 2, 3, 4 and 5 undergoes changes. And in this case what you expect? You will expect o e t here and N H 2, that means; the position of N H 2 and O H N H interchanged.

And, let me take I mean, take you to another example, let us say I will not you just take this one. Now, this N H 2 is replaced by aziridine and o e t remains o e t. And if you do this once again, is a very simple reaction apparently. And what you will see there are other examples, you will see this o e t here and this is nitrogen and this aziridine group here. So, giving this I will give you a problem and you will see let us see if you can give this answer here again I think this is phenyl again ok take oxazole again. And then you have to have 3, you do not have to have 3 substituent by putting 1 more substituent. There are so many examples, and if you take aldehyde and here nitrogen. So, previously oxygen and nitrogen basically they interchange their places right.

Now, in this case you have aldehyde and this azide. So, what do you expect well without must thinking you can just simply write this skeleton first this 2 position side chain is untouched. So, now; you have to do this manipulation if you just carefully look at so; just tell me what you have to do. So, what are the common structure feature that is require you had to have a carbonyl at the 4 position that is important carbonyl at the 4 position. And that remains unchanged so obviously then what should I write here?

Student: hydrogen

Hydrogen that is it so hydrogen and here you will see this asyl so basically asyl azide.

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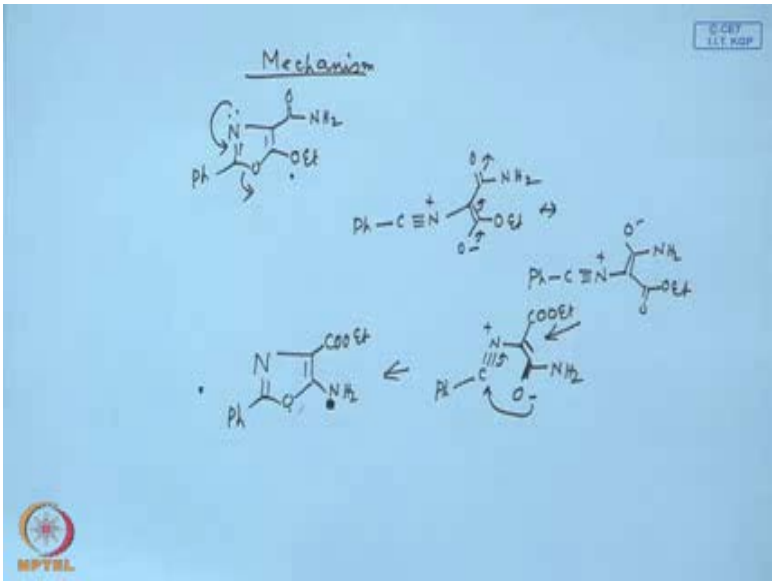

And, so what is the mechanism? So, Let us look at the mechanism there are plenty of examples of this kind mechanistically. Let see oxazole, phenyl and you have to have a carbonyl here let us take one of those examples make the N H 2 as it perfect all right. And this was o e t right what is the driving force? And how do you go about the mechanism? I have given you the clue before in most of the heterocyclic cases what is the mechanism ring opens, ring closes. So, but you have to just identify the right driving force what is the driving force here. I in some case the all these ring opening; ring closings that regard by either proton or O H minus or thermal it is a thermal. Then of course, there is a no handle of protons O H minus.

So, possibly this should be the cleavage driving force that means; P h c right nitrogen here this plus and minus o e t and what it is right this is. And then of course, when you have this you can also think about P h c triple bond this one right oxygen minus this and o e t. So, you can reorient then I think better it should be better if you write this way nitrogen. And then double bond here this is oxygen minus N H 2 and this is now, c o o e t and this is P h and just reverse of the process. And so if you do so; well you can end up with the right you can come up with the right product. And this should be now, o e t this is N H 2 and this.

So, the mechanistic purpose this is perfectly all right. But you have to identify the driving force when I say overall driving force. Then they are isomer in nature then why it

is changing from one to the other any idea? Any guess? They are see if you start with final starting metal this final product both are identical structurally I should say formula wise isomer they are isomeric in nature. Then why should one to transfer to the other obviously, without saying without any analysis you can say that this must be more stable why this is more stable? That means; all other I should say this starting metal is unstable why it is unstable? So, that is what you have to find out actually, I have many more examples. From the examples, what I studied it appears that the oxygen the 2 position should have the group that is less electro negative than the previous or starting material.

Let us say with previous case, you have what oxygen here more electro negative. So, this 1 has to be less electro negative I mean one can in book any kind of explanation as if know 2 dipoles like 2 big trees cannot grow together right. That is a common saying that means; a tree I mean 2 big trees never grow together either 1 of the shorter other 1 the bigger ok.

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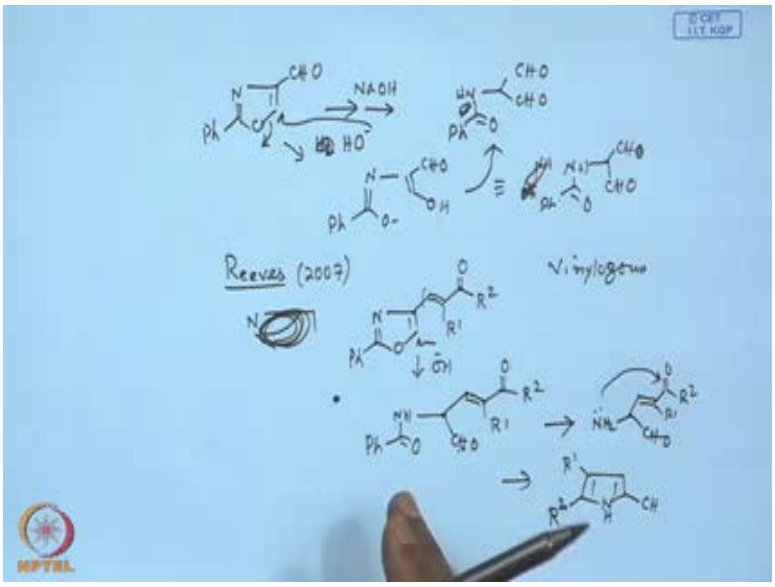

And, then one more base catalyzed reaction is known also again discovered by corn forth very similar substrate here. And if you treat this with sodium hydroxide and of course, it heated. And in this case it ring opens and the ring opening this was discovered in 1949. And the product that is form is N C H O here. So, malondialdehyde basically, you get the aldehyde and N H and P h ok. What is the mechanism? Mechanism wise again O H now, alpha, beta unsaturated aldehyde so probably this under goes Michel addition. Then it

kicks out this alkoxy. So, we will have nitrogen, oxygen minus then C H O and then after all these proton transfer profanization you can get this one this was the original discovery why? Corn forth.

Now, what reeves did he did a small tree here is a pretty interesting reaction it took let us say that means; if you want to. For example, extend this reaction to something else what do you do? This reaction has been known for I will say for oxazoles. Now, you have given a project or you have to formulate a project on this what can I do? You cannot change this oxazole part. Because that is responsible for opening you need an aldehyde you need an aldehyde. Because that actually, activates this molecule towards this ring cleavage so that means; this part cannot be change. So, what can I do then to formulate a new project on this you do not have many places to change right? So, what review did he took a substrate of this kind what is it? It has a relationship with the previous example.

What is the difference between this 2 or difference or I should say what is the analogy between the 2, see they are both are oxazoles. No, problem they both are having the single structure only there is change in the 3, 4 position. But there is a striking similarity ok. If you see here there is a carbonyl up here, there is a carbonyl here. But between the ring and carbonyl there is a group called which group?

Student: vinyl group.

Vinyl group so what is the known as that means; vinylogouslide that is it vinylogouslide that means; all the vinyl see all of us know vinylogous compounds electronically they are similar in reactivity. So, that means; one would expect them under the conditions of sodium hydroxide. So, what do you expect here again, you will get this N H like the previous example N H? Now, here than this one is now aldehyde right so this should be equivalent to an aldehyde. And this is now; double bond R 1. And then rest remain as it is that is it the group remains as it is only the ring opens up this is equivalent to what formal dehyde, hydroxyl, methylene formal dehyde.

So, they basically what you are getting you getting N H C and formal dehyde, then in fact, if you recall the previous example this was N you can say N H sorry N H N H this is P h and this is aldehyde so I mean this aldehyde. So, exactly that is what is happening here so only thing that this portion is this one. Then I think it should be able to tell us what is the product chain, we have learn so much of heterocyclic chemistry here. Now,

almost towards the end of the course you have 2 more lectures to do ok. And so what is the product now? Let us say I will tell you will get a separate kind of heterocyclic hints.

Student: ((Refer Time: 40:03))

Who? Which one.

Student: (Refer Time: 40:07)

Right this one fine right ok this is a carbonite so that means; this is mistake right the good very good this is carbonyl right yes, this is carbonyl ok. So, now; let us

Student: ((Refer Time: 40:32))

Not really, though not really see all these heterocyclic syntheses are based upon reactions of the carbonyl. And amines most or basically all of this carbonyl and something so what you have here now. And you have to find out the relationship I say 1, 2, 3, 4, 5 so that means; a 1, 5 carbonyl means, you will get nothing right 1, 5 carbonyl where do you get if you have in case of pyridine to find our pyridine. But the nitrogen has to come the other way what is the other possibility? Simply, sic base formation alkyl is good enough is strong enough to convert this amide N H CO P h is basically amide is converted to amine. So, this converted to amine that means; N H 2 and this is a C H O then this R 2 and R 1 right.

So, what then this nitrogen undergoes condensation at so what you will get zero that is it you will get the pyrrole. And the remaining aldehyde would be at the 2 position and this side would be R 2 right and the other one would be R 1 that is it. So, that means; you are getting a nice way of making this pyrrole. And this reaction has been extended too many important or other complicated examples. Let me see whether I should talk about it or not. Because they look very similar only thing that the differ how to make this substrate. So, this ((Refer Time: 42:49)) substrate are made by normally by this writing reactions or Wittig reaction ok. And in complicated cases you do this arolol type reaction to get to these sulfur iodine ketones.

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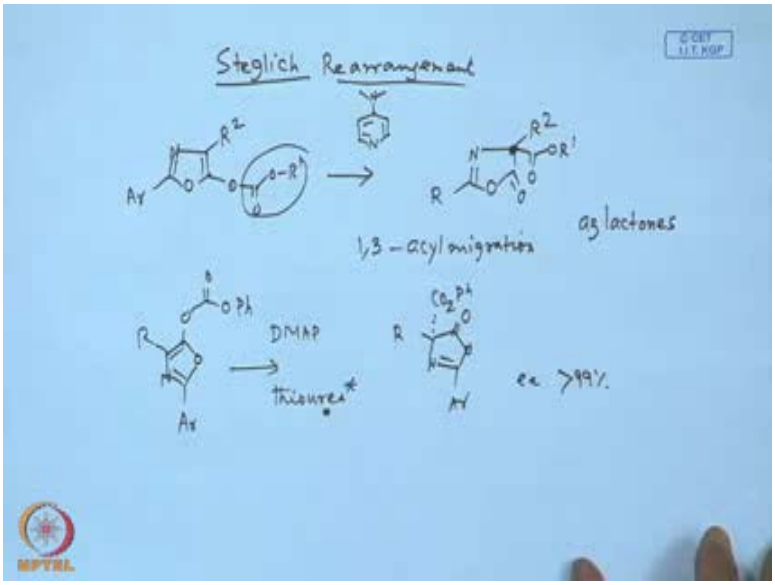

So, this is a very good reaction and there are other examples, we skip them in fact; you can also extended to thiazole systems also. So, that was oxazoles but also you can extend to thiazoles that also eventually. Because thiazoles when alkynes hydrolysis it gives the corresponding aldehydes. So, you will get very similar compounds. The other reactions are that is to be known as stegich rearrangement there is a reaction many of you know called steglich reaction. Steglich reaction is different from steglich rearrangement what is steglich reaction? Anybody knows.

Student: ((Refer Time: 44:56))

Right, right very good what is this ok? Those would do not know it is an esterification reaction is involves this is so alcohol carboxylic acid. And that is the basically this technique reaction. So, you get the Ester formation, so similar reaction again in terms of the substrate because it starts with oxazole, and a substituent at middle of the 2 position. And then if you have let us say group here R let 2 position is now occupied by a sort of a carbonate group and R. R 1 the original discovery was the like this; it was treated with a reagent pretty well known in organic lab d m a p is a is slightly more stronger base than the corresponding pyridine. And under the condition what you will be getting expect to get, you will expect to get a migration of this Acyl group or the Ester group migration.

Ester group so and this is now; as O R minus. And now; this one is a carbonyl, that means; basically this group this a circle group migrates to 1, 2, 3, position 1, 3 migration

acyl. You can say 1, 3 mechanistically, 1, 3 acyl migration. And what you get? you get a product which is oxazolone of course, and what else it has a nick name though anybody, remembers what is the nick name ending with as lactones take this amino acid do the ((Refer Time: 46:22)) is what do you get the basically as lactones. But in this case it is substituted as lactones. And what is the striking feature of the product? Why this reaction is picked up? That must be some reason right.

So, what is the specially outcome as lactones that is fine, but slightly different from as lactones but there is a sticking difference between the normal as lactones. And the product we see here see synthetic chemistry especially I can tell you have to identify the real challenge. What are the different challenges in synthesis that you have to identify? That means; let us say for esterification for example, I mean this is common reaction you can do things but there are certain cases it could very difficult. So, I mean, that means; for any reaction is quite general but not general for all substrates. So, you have to find out the challenges in this case what you are doing here actually you are the creating a new carbon here.

What kind of carbon? Quaternary carbon. Quaternary carbons are difficult to make reason being they are crowd it sees if you have substitution, plane substitution no problem second substitution ok. 3rd substitution you are in trouble. So, that means; a formation of quaternary carbon is challenging. And that is what you have bypassing here through a rearrangement you are coming up with a new a quaternary centre fine what is the next challenge ok. Utility wise is pretty you can see right what is the utility? Utility wise you can go to corresponding amino acid you can just if you just do the hydrolysis we will go to the amino acids you have hydrolyze here N H 2. And this is combined this carboxylic acid so that is one of the way.

And, the other possibility that is sincere producing a pyrrole center. So, you have to see whether you can have an animalistic person, in fact; very recently someone has revised a interesting catalyst again an oxazole here. And this so for steglich rearrangements what you need? You need a like this. And then if you have R group here I will just D MAP. And then a catalyst thiourea catalyst I will not, just I will just simplisafe thiourea catalyst which is a chiral one that is it is a chiral one. And eventually what you will be getting, you will be getting a chiral ester here. And this oxygen and this carbonyl this carbonyl ok and then this lactones this is the different can ester. So, you can also do little bit of the

commercial active reductions. So, you can convert into the siring derivatives all kinds of things. And in the example, that has been sited is a more than I mean 99 percent ok. So, that means; is a pretty useful reaction.

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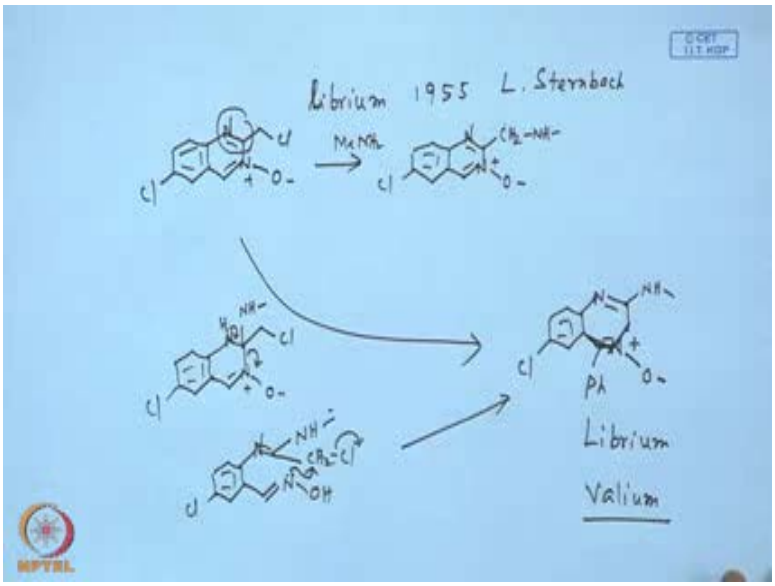


And, let me just quickly I think end of this lecture by saying one another well known reaction which was known was 60s thing many of you must of heard of the discovery of Librium right. What is Librium? I think discovery of Librium this was discovered in 1955, 55 known as L. sternbach why did I say. Because he discovered this compound at the age of 60 means at the time of retirement when he was about to retire he had to submit the sample one of his co workers found that one of the sample was not tested for the biological activities. So, it was submitted for testing and that compound was found with very active means, psycho active means or you can say trunculizer it can induce slip.

And, what was the compound actually was Librium it is nothing. But the structure wise it looks like this 7 member ring it is N H this is methyl group here sorry nitrogen 1, 2, 3, 4, 5, 6, 7 right. Nitrogen here P h and there is a chlorine here and this nitrogen is having oxygen minus this is plus this is an oxide. So, this is actually known Librium it was discovered in 1955. But Helen Lara should market it in 1960 in the name of I think many of you know this valium is nice. Now, recently what people do or what is this rooms use when they are in tension for exam do you know? I know the medical students what they

take because they know what is medicine they should take they take alpha zolam. Alpha zolam is that means; what is this class of molecule known as benzodiazepine.

Azepine means; 7 member ring right you have 2 nitrogen, diazepines; you have a benzene nucleus, benzodiazepine. Actually, stern back what over he wanted to do he made a compound of this kind this one and this chloride here he wanted to displays this methyl mean. And just simple displacement reaction he wanted to do which was to be N H and methyl group here this nitrogen and this chlorine. But at usual most of the reactions do not listen to us ok they grow in their own way. And so; eventually actually he got this one you can work out the mechanism that means; a deduct this see if look at the structure here this is basically imine.

And, what is the by the by what is this skeleton of what is the name of the skeleton? Last class I talked about say you have 2 nitrogen one- three positions you have benzene ring what is the name of this skeleton? We talked about the synthesis synonyms, Phthalazine Student: ((Refer Time: 54:33))

No, Phthalazine we talked about Quinoxaline what is it?

Student: Quinoxaline.

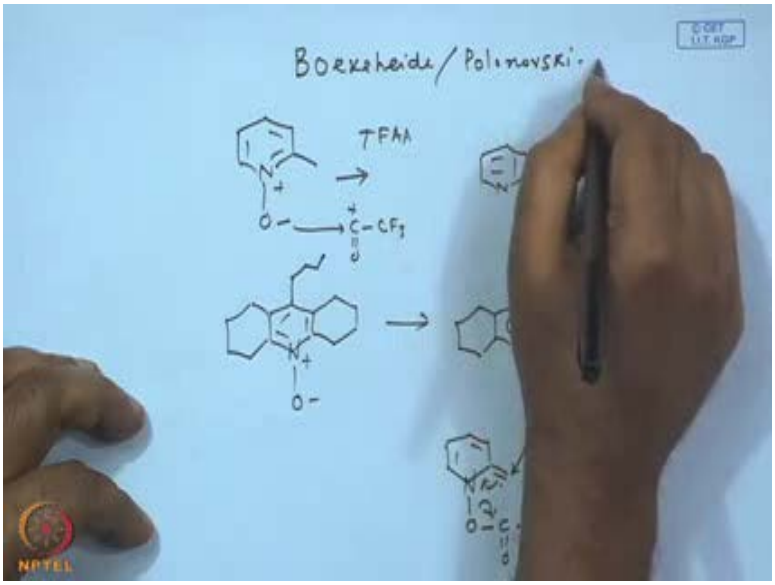
Quinazoline so quinazoline N oxide. So, there are 2 possibilities amine nitrogen could have displays this but it did not displays. So, obviously what was it so it is sort of N like Lola type of condensations right. 1, 2 addition takes place this nitrogen here and this plus and minus. And of course, again like 2 big trees cannot be side by side, 2 nitrogen are to side by side to then want to side by side right. So, what they do? They are satisfied with breaking the ring. And so; what you will be getting, you will be this oxine and other queen all of us know that will remain intact the because this aromatic chlorine right. Now, N H here and this is nitrogen and C H 2 and C l that is it right.

Now, they are pretty I mean now is open and once again is ring closes to expel the chlorine automatic the chlorine minus will pick up this O H hydrogen of OH. So, eventually it will form this Librium ok. So, what is the summary? So, that means this is a now, many of you see is think about this reaction was discovered 1960s. Even today people are working this diazepine simple. Because they want to look for more and more medicines I mean see each individual will have different kinds of this symptoms or

different problems. For example, I know this alpha zolam is all most now, routinely used by many elder people. If you are suffering from insomnia some inom what is that? Insomnia right.

If you do not enough sleep so you can just take 1 alpha zolam not to many. Though if you take too many they are gone, you have to very careful not you will not convert at this for a day you will have nice sleep. So, but chemistry wise what is the summary? That you have covered Achmatowicz, Pain cataly, Dimroth, Cornforth, Staglich all these.

(Refer Slide Time: 57:40)



Then there is also 1 more reaction I did not talk about it that pronovias or boils vehicle hydro rearrangement that also involves. I think just if you have a minute you can just talk about it I think we should know about it though it again this relates to this enoxides. Enoxides I think many of you probably know if you begin with this then trifluoroacetic anhydride probably or just trifluoroacetic acid may be this it could be I think any kind of anhydrides right. Somehow, it is missing overcome what is missing it is trifluoroacetic anhydride perfect all right. So, what you will be getting, you will be getting this pyridine nucleus. Now, and the side chain is now, functionalize and you will be getting this O H here or more precisely if you will get this.

For example, if you have system like this plus, minus this thing, that thing. And you have let us say, you have a groups here if you do this similar treatment what you will find this centre ring would be pyridine, but only this or though substituent would be converted to

the hydroxyl here. And mechanistically actually it first acetic anhydride for attach this oxygen here. And then so; I think you will be getting let us say something like this right because acetic anhydride, triflouroacetic anhydride is basically equivalent to this one. So, it will is a plus 1, so you will get this one then hydrogen is eliminated. So, carbon-carbon double bond is produced then the triflouroacetic acetate this one it goes to displays this acetic right.

Then of course, then once you have a triflouroacetic acid then if you just water that would hydrolyze the acetate to this alcohol this is a pretty common reactions. So, that means; there is a good number of the rearrangement which is based on this reaction this is known as boekelheide reactions. Sometime, people say polonovski reaction polonovski rearrangement ok. So, what is the summary? heterocyclic rearrangement most cases right. Most cases they belong to the ring opening and ring closing which are not ring opening, ring closing. Let us see Achmatowicz ring opening, ring closing right and phenylacetate pian cataly that is also ring opening, ring closing, dimroth ring, opening ring.