Heterocyclic Chemistry
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Lecture - 1
Definition and Scope

Good morning, this is the first lecture of a 50 lecture course on heterocyclic chemistry what I plan to complete in the semester and all of you know the heterocyclic chemistry is very important topic. It is sub discipline of organic chemistry and it covers more than 50 million of organic compounds, 15 million, and 50 into 10 or 6 of the organic compound registers today in chemical literature. So, it is not very easy to task it is very difficult task to cover the chemistry of 50,000, 50 million chemical compounds, but what I will do of course I will refer you to a set of standard text books with most updated preferences.

Occasionally, I will do refer you also to some review articles an some of research papers and to begin with what I will do, I will do talk about definition of heterocyclic compounds. Then I will go to the history little bit then the utility of the heterocyclic compounds in our day to day life and then of course the course structures are what sorts of topics I would cover or the nice structures means it is unlike the regular text books. But, I will have something like a topic organizations and according to my opinion and then of course I will give towards the end, I will talk about the gradients systems of for the course and lastly I lastly and assignment for the next class.

So, let us come to the definitions all of you know definition of heterocyclic compounds or heterocyclic compounds or heterocyclic is that they are organic compounds cyclic organic compounds in which one of the constituent member should be hetero. Hetero atom in which one of the constituent member of the cycle this hetero atom so that is the definition. So, I think I do not have to give illustration but then the question arises what is a hetero atom that important thing you have to little very crateful about it what is hetero atom.

How do we define it while previously I took to basically to take you to the right top corner of predictable if you go to the right top corner of the predictable you will find all the elements on the right hand side of carbon should be consider as the hetero atoms. But, then you have to forget about Helium, Agrium all these things what should be the

two definitions then there are people who have defined hetero atoms like saying that the non metals which are more electro negative or as electro negative. As carbon should be consider as the hetero atoms, but according to me I think the best definition be all this non metals having one pair of electrons I guess that would a better definition.

Hetero atoms in a should be low atoms in a predictable to a able non metals which are non metals and having a one pair of electrons. So, that takes of most of the hetero atoms a what we consider them a hetero atom like nitrogen, oxygen, sulfur, selenium all this halogens they are hetero atoms and work for practical proposes I think all of us know, now what are the hetero atom.

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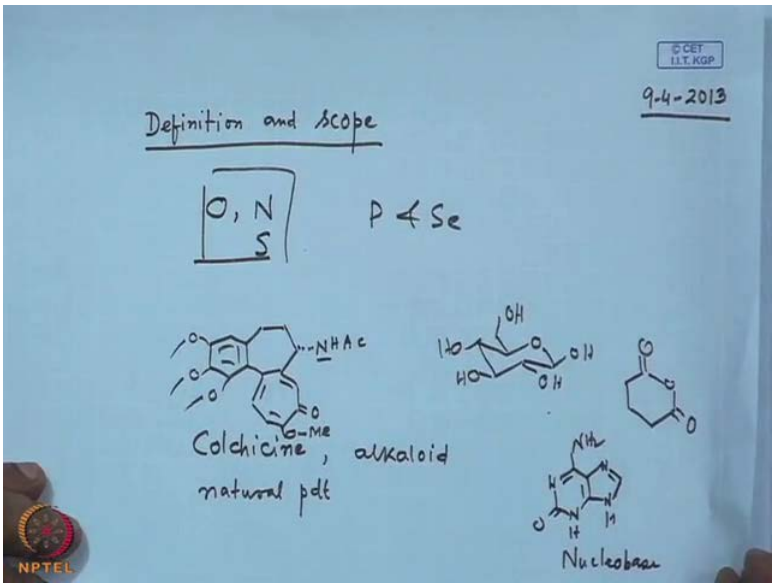

For practical proposes the hetero atoms is a oxygen, nitrogen and sulfur and in organic chemistry domains of course its extended towards sometime to phosphorous some time to selenium. So, that means a primarily this and then of course phosphorous and selenium may be included depending on the situations in some time. Let me take in molecule which is my favorite molecular many most of heard this is a name of this molecule is known as colchicines, colchicines have you heard of colchicines, colchicines is a molecule it has a benzene ring. Then it has a surround ring here then one more several more ring, several number ring and with oxy double bonds here and there.

Then this is O M E and a then N H O, A C E C here and there are three more O M E group A O M E groups this are this and why did I write just to clarify some other things.

For example is say this natural products it is a natural products obtain from a small kind of fault plant probably plant and it is today all of you know used as a used as a anti doubt agent, anti doubt agent this was approved in 2009 as a very powerful anti doubt agent and nothing products. Now, the question is can we call this a heterocyclic molecule a colchicines, I would say it should be classified as alkaloids because it is naturally occurring it assorts physiological activities and it has a basic nitrogen basic nitrogen that is this one.

But, it cannot be consider as heterocyclic because it does not belong to the ring should nitrogen must be constitute member of the ring system should, so it is not heterocyclic molecule let me take up another very commonly of occurring molecules. So, I think many of you know what it is, so you take a 6 member ring, here and then OH O H and O H and all of you know what it is while it is glucose. Now, by definition, by definition would you call it a heterocyclic see the very fast definition what I say heterocyclics. All these definition tools are these organic cyclic molecules in which one of the constituent member of the rings system ring atoms should be a hetero atoms then I have define also the hetero atoms.

So, according to this definition then this must be counseling heterocyclic, but there is, but means see glucose carbohydrate they are as prominent as glucose and carbohydrates means because of this represents of this. So, many high hydros, here and there they distinguish themselves as separate class of a organic compounds, so for convenience sakes for convenience sake we do not consider them as the heterocyclic arguably yes it is heterocyclic.

But, for normal practical classification we do not consider them thought let me take you to another molecule I think all of you know what it is cyclic and cyclic an hydrate. So, is it a heterocyclic molecule this is good and hetero according to the definition it is yes, but we do not consider it is heterocyclic because they are chemical property chemical properties as an hydrate over shadow. The property of the heterocyclic point properties when say property of a heterocyclic molecules I should consider next class and then let us say there are molecules of the this kind.

All of you know that you show what is this molecule anybody know what is this adenosines, adenine sorry, adenine is a heterocyclic molecule is it heterocyclic molecule.

Well, again according to the definition yes but it is more in prominent in literatures as Nucleo base because they occur in R N A, D N A and they can pair up that is there important property they can pair up to form w helixes of these things. So, essentially all though they are consider to be heterocyclic we have to say, but for practical purposes they are not consulate heterocyclic they are basically this Nucleo base that means as nuclease they are prominent in the chemical literature.

So, we can ignore then that means most of them hydro cyclic books would not you know would not rather discuss much about this they will just touch up one and do little bit of the chemical basis and little bit of the properties that is it. So, let us look at that means that definition are clear also there is one more important thing like say when we talked when we studied hydro cyclic chemistry in 1970s, 1970s. If you go the finance book that is the standard text book of the organic chemistry they would only cover under hydro cyclic chemistry only aromatic cyclic compounds.

In those days, in those days elliptic compounds were not postulated to be hydro cycles, but today again the same classification has come back acutely this was proposed by the scientist I had forgot scientist name Albert. He proposed that hydro cyclic compound should cover both elliptic hydro cyclic and aromatic hydro cyclic in fact they classified all these compounds in two groups, first elliptic and aromatic hydro cyclic. So, that means all the proposals was done in 1953 but today it has been accepted and let us look at molecule I think some of you should be familiar with.

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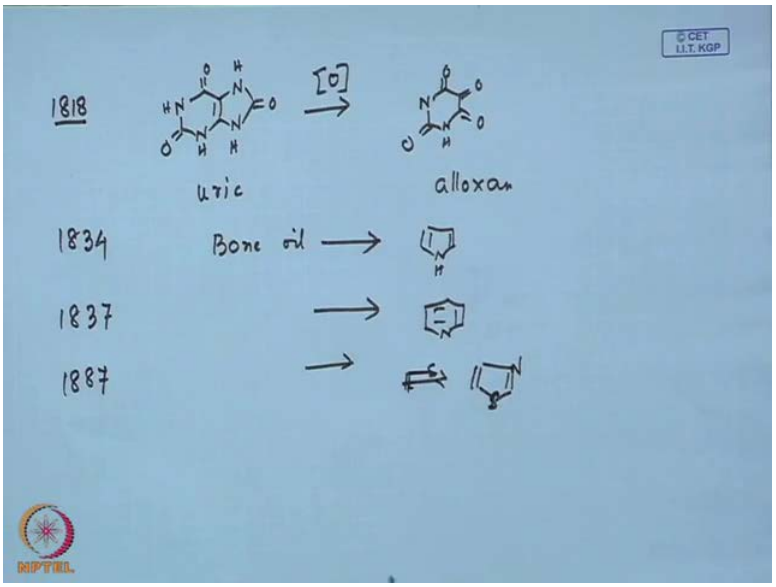

Once again this is the art history of the hydro cycles are the history of the hydro cyclic you say pure in nucleolus and what you can see here this is nucleolus this molecule was discovered in 1818 this easy to remember 18 and 18 long back. Then if you oxidized normally nitric acid caroming acid what do you expect you expect to the molecule of this kind. So, oxygen takes place at the double bond and generated and the other part is area and the some of the people know the name of this molecules what is this name, what is the name of this molecules alloxan, it is the famous molecule classical name alloxan and what is this molecule.

Student: Uric acid.

Uric acid, so uric acid, so the uric acid was no long ago in 1990, so then this is the little of history that means I am going back to 1934 if you take bone oil bone oil and do the dry distillation, dry distillation what you get a molecule.

All of you know what it is that it is spiral that mean the spiral since 19 sorry 1834 then go to the next one which you expect were is similar distillations also produce parody meridian and I mean you can go on writing this thing that thing. But, what I will I will say I will write one more in 1887 a molecule was synthesized and sorry hazel, hazel was known since 1887 what does it means it means hydro cyclic compound known in R D direction of the organic commission.

That means these are not the old molecules they have in the literature for long time now you have to reorganize them rationalize them how do you do how do you rationalize. As I said before Albert suggested that there should be classified as the elliptic hydro cyclic compound aromatic hydro cyclic compound then that was not sufficient too big classes are, so what is to do there I means looked at the chemical reactivity chemical reactivity.

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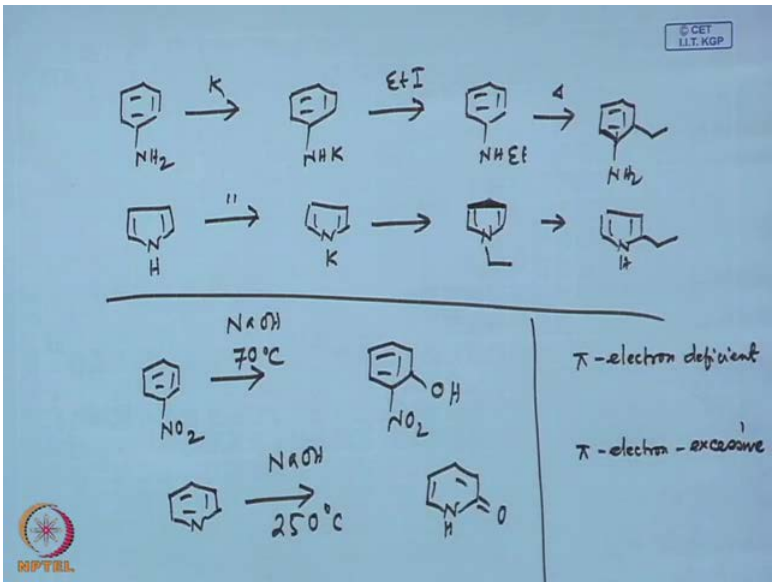

Many of you know if the is reacted with potassium, potassium metal what do you get.

Student: Potassium salt.

Good, you will get potassium salt in and potassium salt then if you treat this let us say ethane iodine what do you expect you expect this engage gets calculated with ethane and then you future heat what do you expect. So, that means it is predictable and ethane methane will migrate to this it, so exactly the same way if you look at if you look at this one repeat the same sequence. So, I think all of us agree that this would form potassium salt then with ethane sorry, so you get this n ethane and then if you heat this you get this ethane migration to the carbon.

So, that means there is the parallel there is a strong resemble between that was the noticeable parallel arte in all details like wise many of you know that if you begin with nitrobenzene and boil with let us say sodium hydroxide at 70 degree centigrade. Any idea what could be the products or the product one of the products is 2 hydroxide, 2

atoms that means basically hydrogen is displaced I mean. Now, if you have very similar reaction with this sodium hydride sorry sodium hydroxide and this request high temperature though 2 centigrade, all of you know what the product is, what is the product 2 pardon.

So, 2 pardon, so you see here that means the regular the regular aromatic chemistry the regular aromatic chemistry will have very strong resembles with this heterocyclic chemistry hydro cyclic chemistry. But, there are two contrasting thought there are many of you know like payroll reacts with domain very rapidly. Similarly, nitro benzene etcetera they are undergoing nucleolus this is nucleolus this is nucleotide addition right or you can say in this case hydro cycles are nucleon file. In this case nucleon are sorry nucleotide in the top case and this in bottom case electro file that mean there are two contrasting behavior and that has given to two very distinct human places.

Many of you know one of them is known has pi electron pi electron deficient pi electron deficient that means with regard to the benzene molecule with regard to the benzene molecule. So, pi electron defection means those molecules which are electro folic in nature for example pyridine, sorry pyridine and the corresponding 6 member with hydro cycle.

Then there are the molecule also known as pi electron well the original odd was little different thought this is pi electron excessive pi excessive pi excessive hydro cyclic. So, that means where do we get when do we get pi excessive and when do we get pi excessive and pi deficient these are two important that means these are two important clue thought that means whenever you reduce the ring size pi different density is increases. So, that means 6 that means what I meant say the ring size matters that is the important hydro cyclic chemistry as you go on proceeding classify different hydro cyclic molecules even in normal temperature also.

The ring size gets the preference in most of the cases 6 member get the preferences and also you know, now two important things as far as the chemistry is constant you have to remember. So, pi electorally sometimes pi defections on pi excessive and like what she said now of course when we study a subject we have to justify ourselves that the topic is very important. Why the topic is very important I think to start with the I said they are more than 50 million, 50 million organic hydro cyclic compounds are known in the

literature today 50 times 10 power 6. It is small molecules it is a huge number so and of course there regions then that means obviously then must be important.

So, what are the areas I have a big list of molecules I can go on writing if I have time I will keep on writing the structures. But, if you go to the Google also you find that if you will type the word you will come up with the hydro cyclic molecule descriptions uses preparation and then toxicity. All these things at the same time there is the structure that means if you are chemist then you should be familiar with the structure and then structural feature that is very all important. So, knowing structure you can at least attach those molecule important two area important area means why they are very important in our day to day life.

In most cases I see hydro cyclic molecule are recognized as the medicines and then there are cases like say synthetic hydro cyclic also useful in hydro cyclic in, I am sorry in agriculture there are, there are insecticides. Then of course in addition to the medicine there are a huge number of hydro cycle molecules features which are used as digs. So, some of the structure then other than that you know that vitamin all other thing all the molecules enzyme all this things and lastly and what is it natural production heterocyclic in the natural product.

This is the last kind of the molecule, this is the though K C Mozmdar of inverse and fortunately I have the chapter also, but because of the limitations of the number of pages. So, we could not write the mass some were, but it covers the whole range of the natural products which features heterocyclic molecules including hypoid erodent and oxidant payroll heron no pyridine all this classes in lastly asinine means 7 member hydro cycles. So, that means the hydro cycle molecules are every were including medicine agricultural chemicals dies and this polymerize and then of course natural production there are some reasons why should it be thought or why should it be learned.

This natural production hydro cycle compounds because they are the molecule they are the molecules they raise give them to the discovery of new drugs many people you would not know molecule is one of the most another strongest pain killer, strongest pain killers. When all the pain killer fails the morphs is used then all of you know morphine is grown by only specialized people or people with license. Any one like I cannot grow morphine in my garden only because of that you cannot which randomly it has to be

prescribed to by the doctor. But, today morphine has given even to many simpler molecules like you do not have to Q 9 for example what it does Q 9 these days people do not use Q 9 what we use.

Student: Analysis.

No, actually we use a simpler derivative that likes the older time Q 9 has such to be used as the as an anti manager, now people do not use it they have found out the Q loony is the active part Parma copper, Parma copper. So, if you do little bit of molecule here and there you may come up with this in fact the chloramines is a molecule synthetic molecules resembling the atom basic part is the resembling the Q 9 part and all.

So, that is basically available in the market as anti man agent likewise there are plenty of examples, plenty of examples where natural product can give to the simpler person of the medicines. For example, if I do not know can you see this structure can you see what is it I think by should be able to know let us say 6 member, 8 member ring another 6 member ring oxtail ring here and. Then this side you have the amino alcohol acid side seen it is the natural products, so natural products it has been by u tree and it is called taco, so tacso.

Student: Antic acid.

Antic acid, I mean useful antic acid, so what I am trying to say that these are I mean there are plenty of justifications then why one have to study the justification I mean I can they said I can give you the structures there are so many structure they all are useful though day to day life. But, as the chemist what should you learn little bit of chemistry that mean there are two except academic aspect and commercial accepts, academic aspect you must know the academic part. Academic part means what is it little bit of the structure little bit of the chemical reactions little bit of the synthesis how to do synthesis.

So, that is I mean that means you have to basically identify the new chemistry while you talk about chemistry means again I am telling you little bit of the physical property physical chemical property and the reactions and the synthesis. Of course, in that you have to see just whether they are being used chemically and available in the market or not when I say the new chemistry let me tell you one or two example probably that will suffice to illustrate then in the new chemistry.

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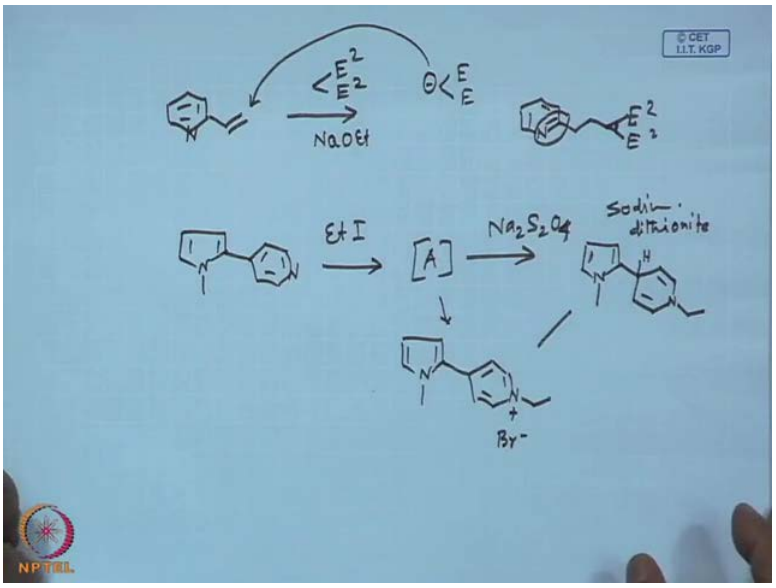

For example, if you begin with at denial Teradyne and I think by now we know what it is E 2 means ethylene ester, ethylene ester, so diethyl marinate, diethyl marinate and sodium ethoxide. So, what is the chemistry we think about chemistry we can think about any guess all of us know sodium ethoxide means it will form the corresponding what next addition. There are so many E S fine, so in this case that means that means each case sort of its micelle addition micelle addition, so what you will be getting you will getting here so micelle addition.

So, how did I visualize we have to visualize this micelle addition how did we expect this micelle addition because this carbon double nitrogen has strong regales to carbonyl group. That mean meridian also as some resembles with carbonyl group because of these main function the adjustment alphabet double bond also is becoming deficient so the micelle addition is permitted. So, likewise there are for example let me take to another example this is little different, now you have payroll nucleolus and meridian nucleolus you do reaction first with you get a compound.

Let us say then you treat with sodium that means we are talking about the chemistry part commercial utility etcetera you have would be talking later just to show you. What could be the new chemistry I will not write this structure I think let us look at first look at first the chemistry part when I say chemistry what should we learn about chemistry of hydro cycle. So, in the previous case we have seen the micelle addition is taking place in the

side although it is not typical, but making the plug out of it. So, similarly what should be the structure here, now if you understand the hydro cyclic part we have already said the 6 member and the 9 member there are two different lights.

So, 5 member hydro cycles are 5 excises and 6 member phi deficits, now tell me whether this ethyl group will go to which nucleolus 5 members because it is electron excesses. So, that means I think, but that is the point what we have proven a wrong because when I see that is the thing when I say phi excesses acutely what it what you mean by that means the ring carbons are more electron rise than the corresponding benzene. So, our reference is always is benzene, so that is it, but at the same time have the pyridine nitrogen which is also nucleophilic in fact this is what happens. So, you have to understand this so that is called chemistry, so typically if you let us say add pyridine to myth lied they are for sometime just slowly methyl compound would formed.

That means nucleophilic substitution is not taking place is added here that is this one and this is, now what is the next thing of course that means this part remains un part the other part is so we guess so N a 2 S 2 O 4, what is the name of the for this molecule.

Student: Sodium

Sodium.

Student: Die.

Die.

Student: Thionite.

Nite, sodium dithionite sodium dithionite what is it is the very good reducing agent very good reducing agent and quite frequently used in organic chemistry and what you will be getting, here you will be getting this dihedron system dihedron system. So, that means I mean there are other example of course as you go on you will see in the next lecture acutely I will talk about the effect of nitrogen effect of the nitrogen. So, the nitrogen can alter the chemical reactivity of particular organic compound and of course in the chemical the hydro cyclic compounds let us look at some of these important actually in commercial molecules.

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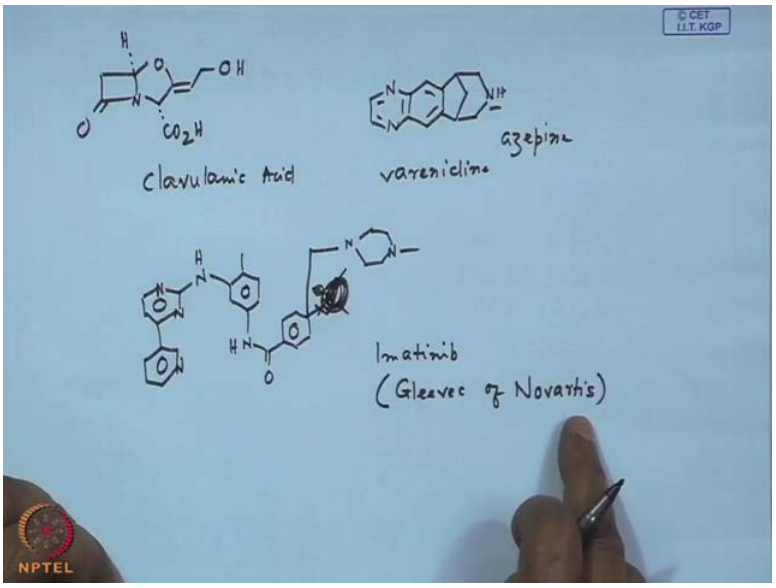

Let us say what I will do I will keep on writing the structure by doing so I will instruct you to do this structure recognizing the structure on the way we will learn some of the usefulness of this organic molecule. For example I think many of you know this molecule Clavulanic acid what is it is anti biotic it is very powerful for anti biotic very powerful for anti biotic and very useful. So, it is affecting molecule, so in this case what it is see it is no additional, not aromatic hetero cycle have to say non aromatic hector cycle.

Then there is the molecule just let us know we have to identify basically the skeleton part this substation all we are using it what is the skeleton one what is the hector cycle skeleton here one is acetum other is other is other is oxalate. So, like say there is the molecule here I will write here that is known this is known as this is 4 member then 7 member here and then have a 5 member this molecule, this molecule is known as varenicline, whatever.

But, for us we have to identify these structural features what is the structural features in these case what is the nucleolus that this as you go on know more about the structure and cases. What is the nuclear sphere this nucleolus hydro cycle 6 member phi origin phi origin on 2 nitrogen 1, 3 per median 1, 4 phi origin. So, then we have one more hydro cycle non hydromantic hydro cycle what is it this is known what is here 7 member drain system with nitrogen is known as azepine nucleolus. So, this particular hydro cycle is

used for the smoking section smoking section means those who want to stop smoking take this tablet and it helps I can tell you for anti smoking other programs there are plenty of kinds of medicine available in the market.

There are patches, there are chewing gums there are injection all kind of things I mean these days very easy to you know stop smoking by taking medicine. One of them is this one the other one it was in the news of the last weak news little big molecule though what is known it is a pyramiding pyridine in nucleus. Then it has a pyridine nucleus then you have nitrogen N h then one more benzene ring why I am writing I am just basically giving the impression about different kinds of the structure different kind of the structures here.

To show the utility of the hydro cycle molecule then one more benzene ring, sorry I think I will write here this is the carbon this is not, this molecule is known as imatinib and commercial name is commercial name is gleavee of Novartis. This is one last week news paper and I have been cutting also here this novatis India fight known I guess this is the anti acid this is very popular anti and this is marketed by Novartis of Europe. But, they used to have this before then in 1995, they introduced one more variety called beta, beta gleavee, beta gleavee this is another crystal form.

They patterned this because the previous one was to, was to expire in 2015 by introducing another form they increase the life 2019 something like that. But, then they went to the code lost it what it is, it is the antic they want it to send it has beta form in the sense other crystal form would be also as powerful as active. But, Supreme Court did not accept that this to form are different they are very similar to each other, but for us it is the hector cycle molecule it is the hector cyclic molecule that you have to identify. What are the nucleus, what are the nucleic non per dime and the 2 benzene ring that means without this compound cannot be active and it is very powerful nice medicine row and people look I mean.

So, seek after this medicine quite frequently and then the other part of this you see here 1 nitrogen and the 2 nitrogen what is the name of the nucleus now previously I said pipe origin now, so that was peregrine.

Student: Pyragine.

Pyragine, this is pipe origin this is acutely pipe origin and then there are there are other medicine quite medicine.

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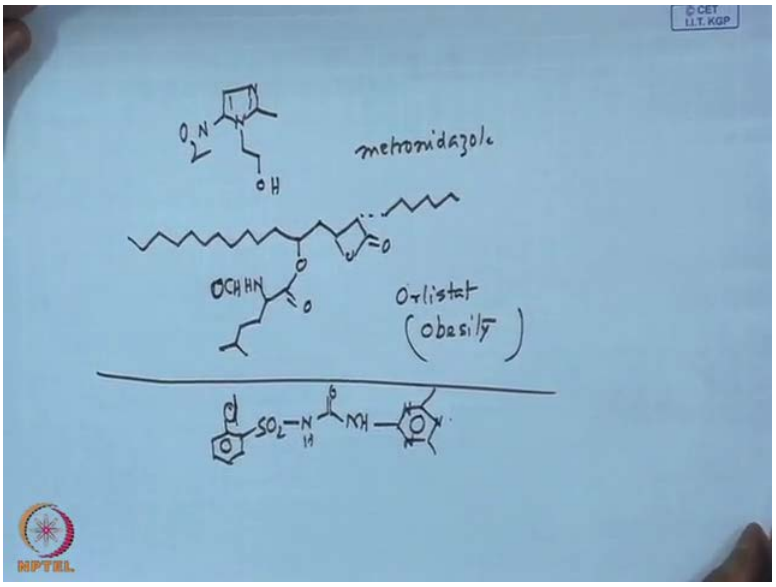

For example let us say I think we should little bit knowledgeable about this one which as very simple molecule very simple molecule what it is I think we should know all about it. From the structure you can find out it is metronidazole, all these medicine are acutely they will have nice I think lastly I will write one more quite important structure.

For example, let us say from the feed of medicine I will right one more structures do not worry of the number of carbons here there is, there is the medicine which will have the amino acid part I do not know whether you know or not then there is N formal, N formal here. So, like the carbon do not worry about the if you remember the name you will find out the structure somewhere what it is do you know what is it orlistat and for us what is as to be known it is the heterocyclic nucleolus. What is the nucleolus, what is the nucleolus oxidant it is oxidant sometime you can see the beta lactones not beta lactom beta lactones and orlistat, orlistat is acutely is used for treatment of obesity treatment of obesity likewise.

So, this is this is for medicine let us say there are the group of the hydro cyclic molecule also used as the extensively orb sites pesticides insecticides and some of them I will just write only one here just to show you that this is chlorine and then sulfur amities. So, sulfur amities is pretty important syndromes for orb sides and sulfur when you say or

sometimes anti, sorry pyretic or anti biotic sulfonamides. Basically, they are having the sulfur groups or sulfur into corresponding and they may be used as antibiotic then pain killer all these things. So, there are sulfur nomads also I should say quite a few, but it is attach to hydro cycles let us to hydro cycles they could be also used as obesities.

So, likewise there are quite few I think and then I do not want to write the let us say some other little bit of these for example all of us know indigo this structure when I say chemistry class means just saying indigo is not enough. In your mind you have to have this structure of what is the structure anybody let us say you have to it has to because the shirt color is blue, blue everybody is wearing blue so it is famous color right what is the structure.

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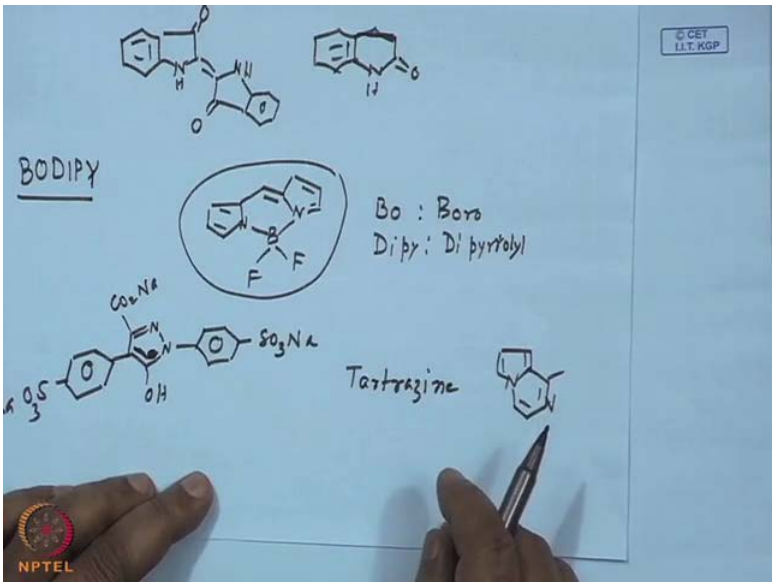

There are two kinds of molecules by the by there are two kinds of the molecules one is this and see in the hydro cyclic chemistry acutely what is this is 2 kitto, this is 3 kitto. Do you know the difference between the names one is this is called oxen droll and this is called oxyndoll, no indoxine oxyndoll indoxine. So, which nucleolus is present in indigo that is what you have to remember, if you can remember that are enough oxen droll, so oxen droll that means they are dynamic form of the form of the oxygen.

So, this is the then there is a very important upcoming class of bodipy it is pretty famous, now what is called the bodipy they are important class of foreseen dice and the structurally. Structurally, it is a it is by primal system by primal systems with double

bond here and there then this is the basic unit bodipy most time B o comes from boron or bora and want is that di pride di pride. So, you can say di primal sorry di payroll, di pyro, di pyrrolyl, di pyrrolyl, so bora di pyrrolyl, so this sort of molecule again it is very use full this flow dice then there are other.

Let us say dice this is quite over load in the market it is the phyrol nucleolus, phyrol nucleolus with the hydroxide on one side and then and you have the sodium salt and other and there are two phenol drink with suffocate group, sorry it is double bond up here. Then just repetition of these groups and this is used by many as food it is the food color acutely this color is used randomly in food this is known as tartrazine and this is then there are I will just write more molecule.

Then I will go to the structure of this course this is for example one more molecule, here 5 member used to 6 member, 2 nitrogen here and then payroll and such a small molecule I mean I have, I mean I have whole lot of structure whole lot of structure. But, I selected the few for medicine agriculture and then this is again one of the safest food dice used commercially and then this one something little deferent. This is acutely it is a flavor, it is a flavor of the roasted meat, so if you can synthesizes this that would give the flavor to the meat and regarding to the structure of this course. Let us say why have you come across the book recently hydro cyclic let us say if you are assigned to teach in a college and hydro cyclic energy what book would you choose.

Student: R K Bansal.

R K Bansal, fine.

Student: Joule and Smith.

Joule and Smith, I think smith is gone now.

Student: Mills sir.

Mills fine, then if you go and follow those book you will be lost because it is very difficult to cover all this area all this suspects from the book in 1 semester even in 2 semesters we cannot reach. So, intergraded because this complexity is, so high in fact unpredictable means there are so many mechanist possibilities unless and until you remembered this would give as you will see question paper.

You see I have given you the questions from the text book, but it is still difficult to work it out in the exam simply because at times you will see nitrogen is new profile carbonate. Sometimes, micelle addition you know sometime it does not is not taking part in reactions just staying outside side seen. So, that is difficult, so that means but books help of course the book that you suggested I think that should be first book.

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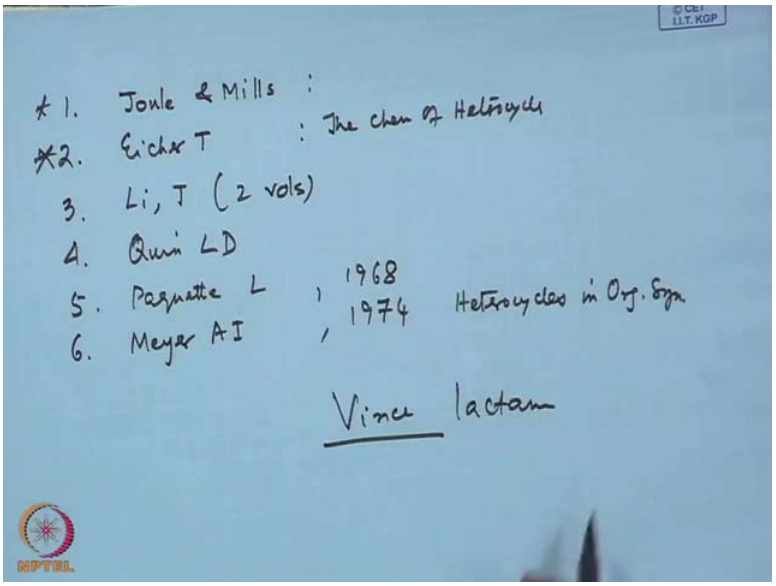

Joule and Smith, Joule and Mills write, so I think all of you know I will just give you the rough name of the name all of you hydro cyclic chemistry and it is very recently it has been published as the addicted person 2010 previous one was I think 2005. So, after 5 years it has again been revised and the book that also I would like you to go through this is known as Eicher, T Eicher there are so many authors I think I am writing the first author. This also name of the book also from the chemistry of the hydro cycles chemistry of the hydro cycles and then I will just write the offers I think probably I would suffice to without exact name of the book. Then there is a book there are actually two volumes by Li, J Li two volume these volumes are dedicated to only the name reaction in the hydro cyclic chemistry.

Now, you can think about this thick book and there are 2 volumes, so you can think about how many name of axis are there in the hydro cyclic chemistry. So, you will be lost really lost, so do not think I mean then there are of course there is a book, here if you are 2 natural products hetero cyclic compounds you can go to this one there is the book

by L D queen, L D queen. But, I will not suggest this is not a good book though although been published L D 2010 then I think there are other book I know like many of you know the book by Gilchrest T L, Gilchrest that is not followed.

Then there is the book by any idea anises book then I think at this book could be a very useful one though Paquette L factors it is pretty famous organic chemistry and he wrote this book long back in 1968. But, I like this book we do with this book pretty useful book and useful to follow start with. But, when people say hydro cyclic chemistry is very easy and it does not bring you names fames and then what is equate hydro cyclic chemistry he started only carbon chemistry, carbon cyclic chemistry well. But, I think I will talk outside class, but the carbon cyclic chemistry defamed him they are reasons, but the book he had written before was very good book because I mean this book is lying in all library.

Then the other book that probably happy to look at this is by Meyers Albert, Meyers this book is published in 1974 it is the new kind of the book acutely the name of the book from there you can make out what is meant to be it is acutely named has hydro cycle in the organic synthesis organic synthesis. That means let us say like the hot set of molecule let us say Joule for example it opens up it gives you that means the hector cycle are being used in the organic synthesis. So, there are similarly other books if you go to my website you can find out, but these are the main books, but for me I take the first two these are the useful and structurally how do I cover the whole topic.

First we will have some then little bit of this structure determine there are very difficult book because you do not have many protons in the hydro cycle molecules. So, difficult two structures find out this structure, so we will talk about that then the effect of nitrogen basically effect of hector atom its self is a good enough. If you can locate and relocate or identify the effect of the nitrogens in the reactivity and then mustard hector cycle chemistry very easily.

So, that is important area because nitrogen can do all kinds of right it can stabilize carbon it can assist the generation of carbon iron all kinds of wonders then it can assist the as well as transfer metal all kind of you can do. Then there are some specialty reaction, specialty reaction like you have already seen that the cycle reaction then what is the specialty reactions in hydro cyclic chemistry multi component reaction. Many of you

have that you have multi component the simple example of the multi component is molecular lesson.

So, it is entre in the money it can give rise to the variety of diversity of the diverse range of organic chemicals then what I have done also in this course that I have revised the synthesis to 4 groups. When I say payroll groups all, when I say payroll groups all the 5 member compound tetra atoms like even the etcetera all these things. When I say presidium payroll all this things including then next one of course this indo, indo all of you known little special one the benzene plus payroll. So, it resembles strongly to payroll, but there are some remarkable chemical feature which are different from payroll itself, so then of course already is been talk about the hydro cyclic re arrangements.

We have talk about group of the reaction are known which are to be hydro cyclic re arrangements then since then of course there are other things there are two important topics called I have building blocks and theory. There are plenty of atom which can be used as lignite and catalyst etcetera and then they can also use the building blocks building blocks means they can provide carbon nitrogen necessary for other organic synthesis. There are quite a few famous name we have already methane also cyanide as lepton they can be used dynamites urea, there is the new group of atoms called veins lepton I do not know whether you heard of it Vince if you go to the chemistry literature Vince Lactam.

So, likewise there are a group and of course I think, so likewise and there are of course I think there are groups when I special topic it can be also special topic let us say among the special topic what we have first. Let us say for useful especially as many all of you know then hector organic synthesis also a important topic like say fungal for example fungal reaction benzene to form the corresponding bi cycle compound. They can be diverted to so many different kinds of the structures and they have been made useful also in many total synthesis.

Then there is another aspect of as the organic chemistry once you know how to introduce the fluorine in an organic molecule how do you do, let us say you have the organic mole I said you introduction of the fluorine atom in the sustain how do you use fluorine of course the fluorine cylinder. But, it is available, but the fluorine cylinder is available, fluorine cylinder and you have to import you do not have to anything here and what do

you do, I do not know. Whether you have seen fluorine reactor fluorine reactor would have the special kind emplaces that should be imposes fluorine.

The cylinder containing fluorine will have only 1 percent or 2 percent fluorine diluted means something else I forgotten it could be nitrogen probably, sorry oxygen probably oxygen and fluorine mixed together and only few percent is fluorine. That is good enough as the source of fluorine and other than that what are the other fluorine source at fluorine acid this thing. So, that means tri fluoro methane group is very important structure that can be used in the introduction of the fluorine what else.

Student: H F.

H F, very good H f and then there are regions like P P H Pyridine complex then so this actually important all of us know because introduction of fluorine acutely improves medicinal properties of many drugs.