Structures, Stereochemistry and Reactivity of Organic Compounds and Intermediates: A Problem-Solving Approach
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Lecture No. 11
Conformational Analysis of Perhydroanthracene

Hello, welcome back to this course on Structures Stereochemistry and Reactivity of Organic Molecules and Intermediates: A Problem Solving Approach. In the last lecture we have seen the different the diastereomeric forms of perhydrophenanthrene and then we have discussed the confirmations of that these molecules some of these molecules can adopt these molecules means the perhydrophenanthrene, we have seen that perhydrophenanthrene can exist in 4 dl forms and two optically inactive forms out of which one is a true meso compound and the other one is a exist as a non-resolvable TLPR.

Now, before we start go on to the Perhydroanthracene, let me emphasize that what is the importance of this conformational analysis, because this especially perhydrophenanthrene, perhydrophenanthrene systems are present in various natural products which are of tremendous importance like steroids, the ABC ring of steroids and the ABC ring of Triterpenes, Triterpenes which is another class of molecules which contain 30 carbon atoms and thier ABC ring resembles the or this a same as what is present in perhydrophenanthrene systems.

So, confirmation analysis is important because you know confirmations will ultimately dictate what type of reactivity these molecules will have, what is the energy parameter, whether it is a high-energy species or a comparatively low energy species or you can actually make a gradation of the energy scale of different perhydrophenanthrene. So, that means different steroids skeletons, different Triterpenes skeleton.

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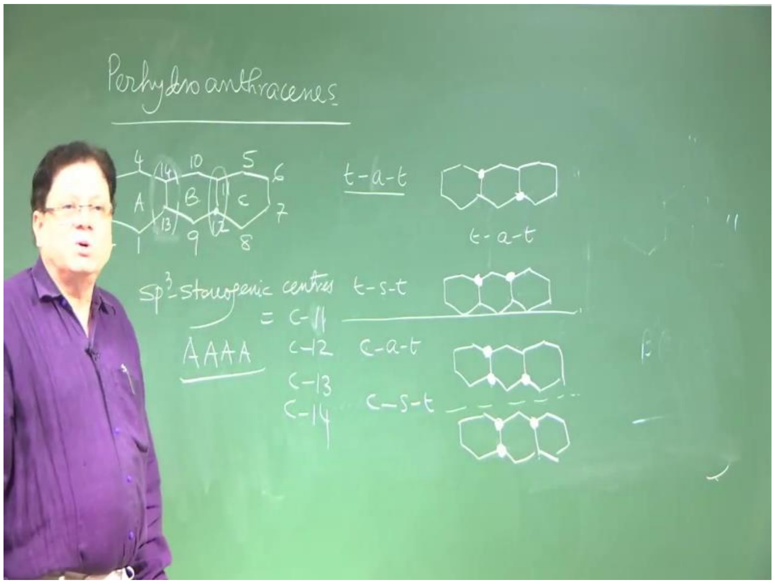

Now, let us discuss the perhydroanthracene which is basically the fully reduced form of anthracene, the perhydroanthracene. Now, remember this is a system unlike the perhydrophenanthrene which is the ABBA system, this is an AAAA system, because all the stereogenic centres force stereogenic centres have are connected to similar type of atoms.

So, this is one, this is another one and this is the third one, this is the fourth one, the numbering again here the numbering is not at all complicated here basically you can start from one of any you know in anthracene these are the 9 10, so the A if this is A ring and this is B ring this is C ring, so you can give number 1 here, number 2, number 3, number 4, but then jump here 5, 6, 7, 8, 9, 10 and then this is 11, this is 12, this is 13 and this is 14. So, that is the numbering system.

So, what are the SP3 stereogenic centres? That is the this is the 13, 14, not 13, first 11, 12, 13 and 14. So, these are the 4, but because they are having the similar type of atoms connected so they are all this is an AAAA type molecule. Because of extreme similarity so that will reduce the number of isomers in comparison to the perhydrophenanthrene, we will see that what are what is the scenario here.

We will go again step by step like what we have done with perhydrophenanthrene, so the out first here again two types of relative stereochemistry can occur one is the ring junction stereo chemistry and there are two ring junctions stereochemistry is possible and then the relationship between this either 11 and 14 or between 12 and 13, that means the relationship between atoms which are not the fused atoms between the between the two rings.

Because 12 is the common to B and C, the ring fusion carbon between B and C and 13 is the ring fusion carbon between A and B, or you can consider 14 and 11. So, you start with giving this this is the same type of notation cis it could be cisoid the ring junction could be cis or trans and the relative stereochemistry between the non-ring junction atoms will be either cisoid or the transoid.

So, one could be t, the first one you can say that t and then anti and then t, that means trans, transoid and trans, so which here the transoid we are not using we are using the word anti, anti also means the transoid, so t-a-t is the first one, so what is t a t? Quickly you can draw it, so you can put here 1 bolt this is we are not showing that means the hydrogen is alpha this is beta and then you have anti that means this you not you should not show and this is the 1. So, this is what is called t-a-t.

Then you have systematically t-s-t, t-s-t, so t-s-t will be what? t-s-t will be so again trans s that means this is also beta and then you do not show it, because that should be your trans, that is trans, so this is t-s-t. So, these are the two, then you change it c make one t as c cis is and then you have c-a-t, so what is c-a-t? You have this is the ring, system then you have cis, so if you have to have cis that means this is beta and that is beta that makes it cis, then then is anti, so that is alpha and then there is trans, so that has to be beta.

Then the other one is c systematically c-s-t that is cis syn and trans, so what is that? cis syn trans and then cis means this is beta and then sync cis syn this and then that one. Now, here is some one important thing to notice that this is what is called cis, then anti and trans and this is what is called cis syn and trans, if you start from this direction, that will be your trans, trans syn, actually what you see here that these two are basically belonging to the no not this one c-a-t and (())(08:40).

So, systematically we should proceed, we have syn t-a-t, we have syn t-s-t, then to start to change one of the t, terminal t's to cis, that means cis so that will be cis, anti and trans, so you draw it cis anti and trans and then you draw the other one which is already drawn, cis syn and trans, so cis syn and trans, but one thing one should be careful that is apparently this looks like a mirror the if you put a mirror here they seem to be mirror images of each other, so let us see whether if it is mirror images so their relationship will also be the similar, only the directionality should change.

So, this when we start from this carbon, so cis and then anti and trans, that is okay, but if we start from this carbon and go this way in the anti-clockwise direction, so that becomes cis syn and trans. So, this is what is represented here. So, these two are basically representing the same, same stereoisomer, stereoisomeric system, we are not very sure whether that exist in dl form meso we will go into that, but we cannot have both because both are representing the same, it is the way your starting point is.

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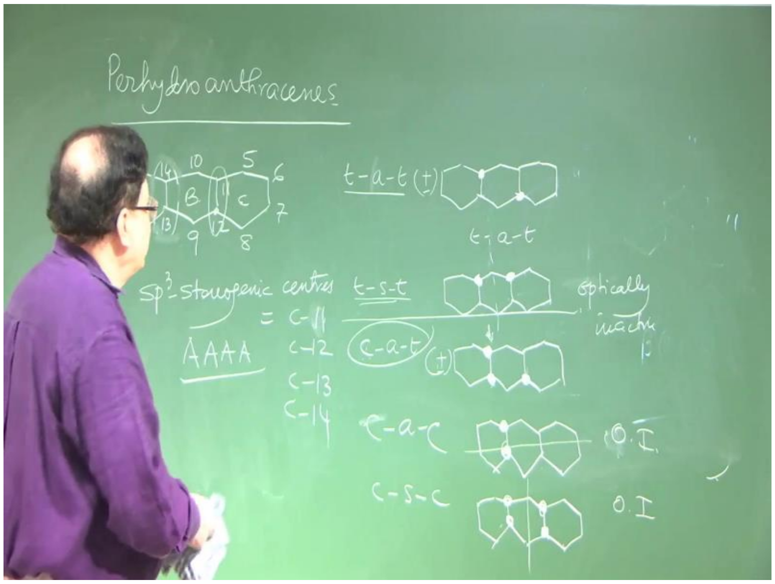

Again, I repeat the one that I have written here is what is called the c-s-t, so c-s-t means basically c s and t, but what I am saying that if you look at this molecule c-a-t and start your nomenclature system from this end, so that will be cis and then syn and then the trans. So, it is basically the cis syn and trans, so you just see, so that is because it is a 4 A system that means AAAA system that is why this is happening, it did not happen in perhydrophenanthrene.

So, these are the three then you have some more and that is now you have c-a-c that is a possibility change both and that will be so that will become cis that means both beta then anti do not draw it and then cis, so this is the one, c-a-c that means cis and then anti, cis anti and then cis. This is the fourth one and there is one more that will be c-s-c, that means cis syn and cis, so that will be basically you have so cis means so basically all 4 are having a bold hydrogen, so that is all 4 are beta.

So, these are the these are the 5, now these are the 5 you cannot actually get any farther because you have exhausted all options, first there are two t's at the end, so in the middle there will be either s or a and then there will be one c at the end and one t at the other end and then it will be either a or it will be s, but they are becoming same because as I said because of the symmetry that is present in that the 4 A system and then you have c-a-c and c-s-c.

So, let us take some of these and try to figure out. Now, again the earlier what we have said that the conclusion that you get from the planer looking at the planer system it will be whether optical activity is present or not, that will be that will be similar even if you do the confirmation analysis. So, here there is a planer symmetry here, so that should be optically inactive, there is plane of symmetry, there is a plane of symmetry here and there is a plane of symmetry here also.

So, these are the systems, so your what will happen your t-a-t that means here it is t t twice, you can call it as a actually it should be trans, transoid and trans, so that is t-t-t, but here we are not using the transoid word we are using the anti word, so that becomes t-a-t. So, t-a-t exist as a plus minus form, as you can see that there is no plane of symmetry possible here, then you have t-s-t that exists as a that should be optically inactive because there is a plane of symmetry.

Then you have this c-a-t, c-a-t or c-s-t the same thing, so that will be also in the plus minus form because there is no plane of symmetry, then you have the two forms which will be both optically inactive, O I, I can say. In fact in these systems I can tell you where ever it is optically inactive in these systems they are actually real meso, that means here the flipping does not provide the mirror image, so that means they are actually real meso compounds, there mirror images are superimposable with each other. Let us, take any one of these and do the confirmation analysis or draw the correct confirmation. So, let us take the t-a-t.

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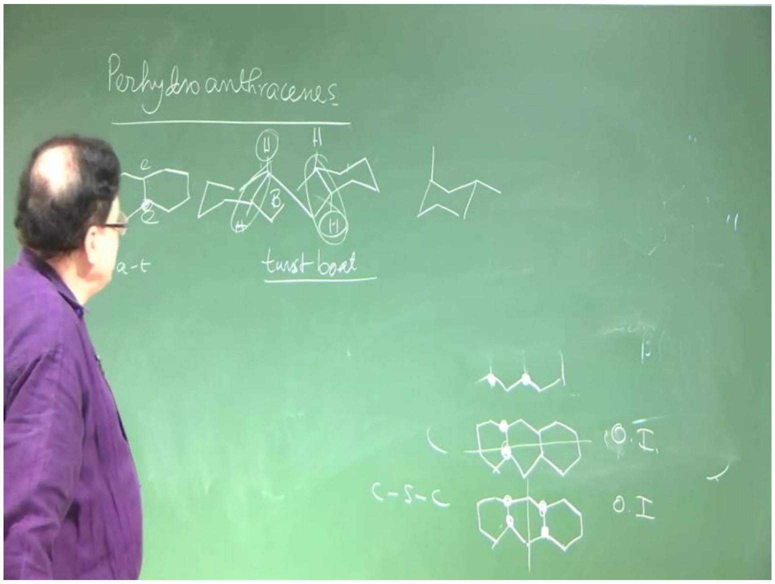

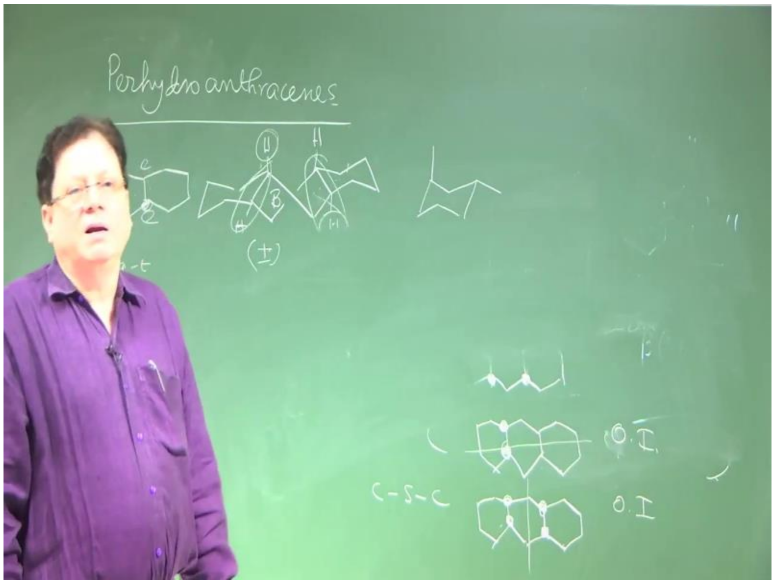

So, t-a-t if I want to draw this, where is my starting point? My starting point is that I have to assign the axial equatorial nature of the hydrogen's, the axial equatorial nature. So, this is your t-a-t, let me erase this part, so that I get enough space, so this is your t-a-t and so the hydrogen here is alpha, since it is a trans ring junction, it is trans ring junction you know that that has to be the axial.

So, this is axial hydrogen, this is axial hydrogen, then there is this is 1 3 relationship, so that will be equatorial and that will be equal to your because 1 3 remember in a cyclohexane system if you want to have 1 3 trans systems so if one is axial the other one is equatorial, that is 1 3, 1 3 trans relationship. If it is 1 3 cis relationship, then both the bonds have to be similar in nature, that means either axial or either equatorial.

Here it is 1 3 trans relationship with in the B ring with respect to the B ring. All the actually orientations are all with respect to the B ring remember that and then so that will be equal to axial equatorial, so that again tells you that there is a problem, because trans ring junctions cannot incorporate di-equatorial hydrogen's. So, that means the middle range like the previous case in perhydrophenanthrene we have scene that will be in the this is the middle range status of the middle range that means the B ring and where is the A ring?

The A ring will be something like this will be like this let me see whether something like this and the other ring will be something like that. So, this is the hydrogen, this is the hydrogen, this is the hydrogen and this is the hydrogen. So, these are the, so these are all trans ring junctions that is also trans ring junction and what is the other relationship? Relationship between this and that that is also anti to each other. So, this is the correct representation of this t-a-t molecule.

So, this is the B ring in the twist boat. And what will be the additional energy over the cyclohexane's additional butane interactions that you are in countering by fusion of this of these rings, that energy will be basically the because you are not in-cooperating any for the trans ring junction but what you are having is a twist boat form middle. So, the energy of a twist boat form is the additional energy over the cyclohexane (())(18:41). And this does not have any so this is existing in a plus minus mixture because of the you can adopt the numeric again and you can check by yourself, so that is a plus minus mixture.

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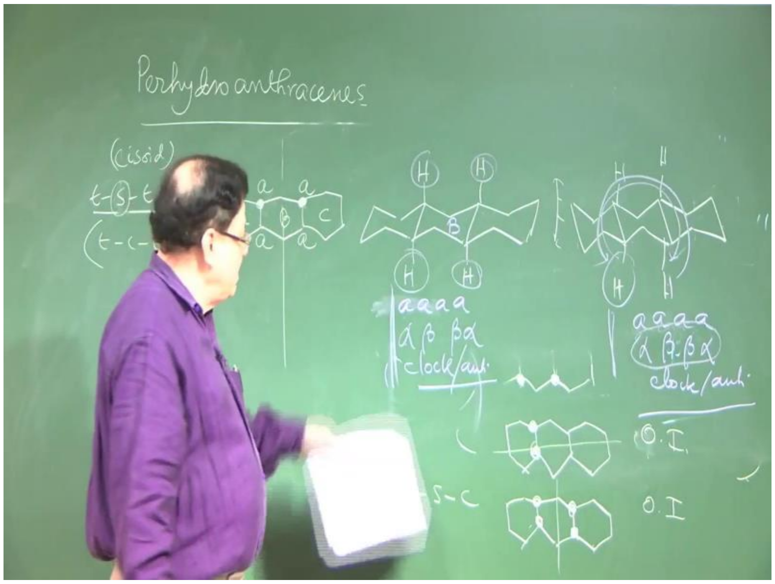

Then we will take another one let us see the suppose the t-c-t, what is t-c-t? First draw the planer form then try to assign the relative orientation by putting dark circles or not dark circles because they starting point is a trans ring junction, so you make one dark and this is alpha hydrogen, then you have a t-s-t, you cannot call t-c-t, s t, s means syn, so if it is syn or if it is c that means you are basically talking about cisoid, if it is t-c-t remembered about this nomenclature system, if in the middle there is c that means it is the cisoid, in the middle if it is t that means transoid or if you see the other previous nomenclature syn, syn means that cisoid or anti means the transoid. So, this is either t-s-t you can call or t-c- both are same.

So, this is syn so syn means now that means non ring junction hydrogen's are basically syn, so you have the beta here, because you have to make them have similar alpha beta nature similar this is beta so that has to be beta, this is the hydrogen which is alpha. So, this is a planar form. Now, you have to put the axial equatorial nature, so if trans ring junction, you know that this has the hydrogen has to be axial this hydrogen has to be axial, this hydrogen is axial and this hydrogen is axial, because 1 3 relationship it is either di-axial or di-equatorial, but started with an axial here, so there has to be axial.

So, even now draw the rings this is actually the easy one, so you draw the rings, so this is the situation, so all the rings are in perfect chair conformation and then perfect transferring junction. So, there is no question of any there is no question of any flipping by because we have said that if any of the fusion is trans then the flipping is stopped. So, molecule becomes rigid and this should have a plane of symmetry going through here.

You can also check this by drawing their mirror image and see that they are superimposable on each other that is also you can do, so these are all the hydrogen's and what will happen? You have here suppose this you go from equatorially axial axial axial axial axial axial and this is axial to this B ring, here of course this is axial to the A ring also, but remember our orient notion is always with respect to the B ring.

So, this is axial axial axial axial, this is alpha beta beta alpha and the direction is if you go this way then the direction is clockwise, the direction is clockwise and if you do the same thing here see actual axial axial axial axial of course you can take from here go to there or you can go from here come to here that is also okay, because all are actually axial.

So, there is no difference here however because you have made it alpha beta beta alpha, so better do it alpha beta beta alpha however I should also point out here that this is alpha beta beta alpha, so you can go from here also to come to this via this route, you can come here, this is alpha beta beta alpha. So, this is basically clock or anti-clock lost both are possible here. So, you have to write both that will be better otherwise you may land in to a problem, if you pick out a particular one.

So, again here alpha beta beta alpha, so again both possibilities are there, clockwise or anti-clock wise, so clock or ani-clock, you have understood I hope that because what I am saying that if you go from here and go this way you have alpha beta beta alpha or alternate way if you go from this to that direction, that is also alpha beta beta alpha. You should you cannot actually you should not go this way because that makes it alpha alpha beta beta, but we are not following that, we are following alpha beta beta alpha. So, both these directions are possible, clock or anti-clock.

So, if you now compare these two they are basically the same, because everything is matching, so that means it is a perfect meso compounds, this is a perfect mesa compound, we will take let us take one more.

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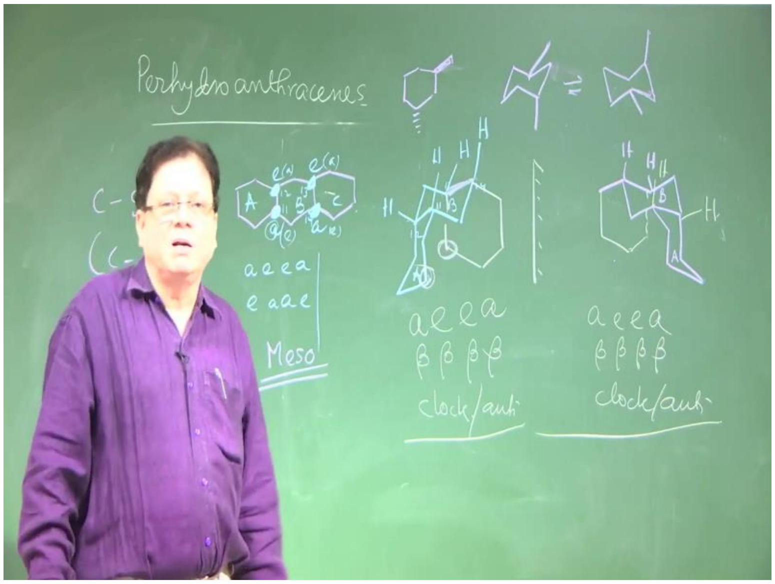

Suppose the c-c-c, c-s-c or that is same as c-c-c that means cis cisoid cis the other nomenclature is cis syn and cis. So, first draw the planer form, so because it is cis that means these are bold, this is bold, this is then syn or cisoid, so all the 4 hydrogen's we make it we have to make it bold. So, now in order to do the conformational analysis we should draw the confirmation and you have to assign the axial equatorial nature of this hydrogen's.

Because it is cis, so you can start with say axial equatorial and then because it is equatorial so syn that with this has to be equatorial, then this has to be axial, alternatively you can also start this is equatorial, this is axial, this is axial and this is equatorial, let me two types of possibilities are there axial equatorial equatorial axial or equatorial axial axial equatorial, both possibilities are there.

So, let us draw the confirmation, first draw the B ring and then appropriately put the hydrogen's, suppose this is your 11, this is 12, this is 13 and this is 14, so 11 hydrogen is beta, so you have to make it beta as well as if you start by putting axial then your 11 hydrogen should be here, because that puts a hydrogen at the beta or it could be here that is also possible, you have to pick up a beta axial hydrogen, so pick up a position according to that.

So, I do it from here that is easier, so this is 11, this is 12, this is 13 and this is 14. So, your first ring looks like this, this is your A ring, A this is your B and this is your C, so A B now the C ring, put the hydrogen's also hydrogen here hydrogen there and the 13 14 ring junction that is also the 13 hydrogen is we are taking the first one that mean axial equatorial, then equatorial so hydrogen is equatorial and then axial hydrogen is axial.

Now, you complete the other ring put some different colour here that will look better. So, the other ring will now unfortunately that will look like this, because you are seeing in such a direction that the projection becomes a hexagon. But the ring is in the chair form, do not be do not get any means conception that representing this means this is in the hexagon that is not this is in the plane hexagon that is not true, it is in the chair form perfect conformation.

Now, the because there is a possibility of possibility of your flipping, because the ring injunctions are not trans here both during the options are cis, so flipping is possible. And that is one aspect, the other aspect is the energy consideration, energy consideration again very similar to the earlier what we have done with perhydrophenanthrene that here there is this methylene methylene interaction is there, so you have to count that.

So, what I said at that time that if you this methylene and that methylene is there and then you have this cis configuration, so cis declain gives you 3 extra, so two cis decalin means six extra. And the mirror image let us draw the mirror image of this and try to see whether they are superimposable or not, because that will tell you whether it is a true meso or it is a non-resolvable TLPR.

So, if draw the mirror image, so draw the mirror image of the B of the that B chair and then the other ones that means you are now the 11 is here, so that ring will look like this that is the A ring and this is the B ring and you are C ring will look like as I said we look like a plane hexagon. So, this is the mirror image.

Now, the question is are they superimposable or each other or not. So, what we will do? Again we will adapt that mnemonic so here suppose we give from 11, 12 and then 13 and 14, so 11 is with respect to B this is axial, then equatorial, then equatorial, then axial, all are in the beta orientation and the direction is again what it would be clockwise again the similar type of thing happening because you can come from this axial, then equatorial, then equatorial, than axial or you can go from here axial, equatorial, then equatorial then axial. So, both directions are possible.

And here if you do the same thing fix this it should not change this so that is axial equatorial equatorial axial and then all are beta, beta beta beta beta and the direction if you go through the direction again both are possible either you go from this axial take this route or this axial and then take the route in the clockwise direction, so both are possible clock anti-clock wise. So, that means both are same, so that means that this is a true meso as I have already said that this is in case of perhydroanthracene, because of the AAAA system so all are becoming the meso is here a true meso that means the mirror image is superimposable to the original one.

And so the question is then what is the flipping? What is the that relationship between the flip form and the original? Basically, they are not the same the flip form are not the same with the flip form is the same with the original not the and the mirror image also same. Remember the the 1 3 trans decalin system 1 3 trans decalin system, so this is the scenario, here what happens that if you draw let me correct actually whatever I have seen just a few minutes back that if you have this as the equatorial, this is beta so better make it this methyl here at the other methyl to make it trans will be an axial.

So, equatorial actual relationship, if you flip it then you get you get this is your so that carbon comes here, so this will be your axial and this will be your equatorial, if you try to find out the relationship between these two you will find that they are the same here, that what I am saying here what happens and if you take the mirror image you will see the mirror image is different here the mirror image is actually different from the original.

Here what happens the mirror becomes same, now my question is that here flipping is possible because both are in the cis having a cis ring junction, so flipping is definitely possible, so if you flip it, you will not generate a new system, you will generate the original system, through flipping. Like a cyclohexene chair if you flip it, although it looks like a mirror image chair, but they are basically superimposable on each other, they are not different, so that is an important point, fibbing is possible, but that is not changing the optical activity scenario of this of this molecule. I think since there is little time left we can take another molecule and then try to draw it, to make it more clear.

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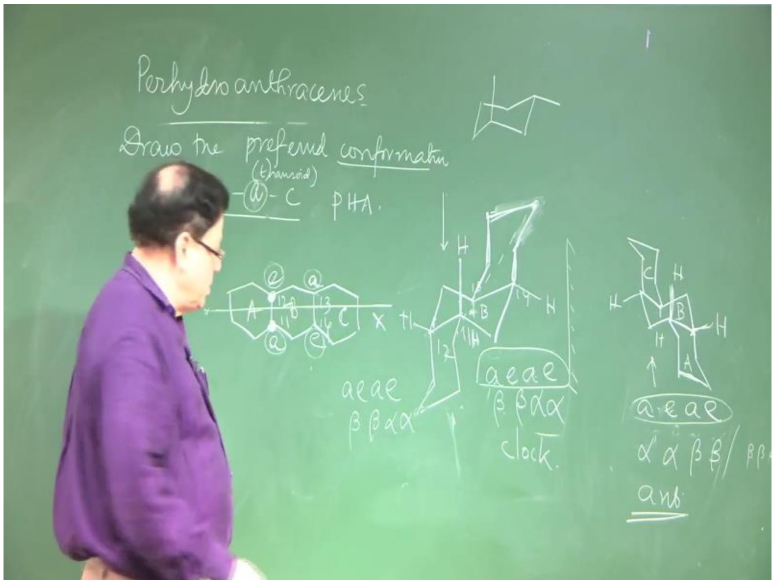

I think we have not done the c-t-c, so the question is draw the preferred confirmation of preferred of c-t-c form of perhydroanthracene, so c-t-c form if that be the question, then first draw the planar form, like what I have said, they make it a cis c-t-c actually this is transoid so you can say a also see the problem is either if you write only t then it does not differentiate between trans and transoid, so that is why I generally follow the syn anti which does not create this confusion, otherwise you have to write all the way up to transoid, that is a big word to write, so better for abbreviation purpose this a and s are is better.

So, c-a-c, so c-a-c means cis anti and cis, so cis and t anti and cis means this is cis then anti that means this has to be alpha and this has to be alpha because in order to make it cis. So, this is the planer form, planer form says that it is a meso compound because there is a plane of symmetry, let us see whether it is a true meso form or not, but in order to do that, we have to draw the confirmation.

In order to draw the confirmation we have to first assign the axial equatorial nature of the ring junction hydrogen, so that is hydrogen, so since it is cis so you can start with say axial, then this will be equatorial that makes it cis and then there is since trans relationship between these two these two hydrogen's so this is 1 3 relationship 1 3 means this has to be axial because it is they are anti to each other again just if you are not that converts in you can always make it clear that yes, if one is at equatorial then in order to make it a trans the other has to be axial or if one is actually rather has to be equatorial.

So, equatorial axial and this has to be equatorial, because this is syn this is cis ring junction cis ring junction. So, now you draw the B ring first do not draw the A ring the trick is that draw the B ring first, so draw the B ring in the chair form. And then sometimes they are maybe some problem as I said that there is one molecule which was basically t-a-t for which the middle ring was in the skew boat or the twist boat form.

But you can actually come in to that conclusion anyway, if you even if you draw the B ring as the chair form you will be having trouble later on to construct either the A ring or the C ring. So, when you have these problems you can immediately realize that the B ring has to be in the twist boat. The other way that always look at this ring junctions, if you see that some of these ring junction orientation are in are is not possible like I equatorial hydrogen's in case of a trans ring junction then you know that the B ring has to in skye boat or the twist boat conformation.

So, here there is as such no problem, so you have because there is no trans ring junction here, so this is your B ring and then your A ring the A ring hydrogen the 11 hydrogen this is 11, 12, 13, and this is 14, the 11 hydrogen is beta, so you have to make it beta and it is axial, so beta axial, so that is your starting 11. Then 11, 12 and then 13 and 14. So, 13 and 14, so that makes it this axial equatorial and then you have this 13, so 13 hydrogen is alpha, so this is your 13 hydrogen and 14 hydrogen is also alpha equatorial, so your other ring goes like this, sorry my drawing was appropriate let me so this is the scenario. So, this is the so all are in the perfect chair orientation that is not a problem and both are injunctions are in the cis orientation.

Now, the question is it predicts the planer form predicts that it is a meso compound like we see interesting point is that it does not have this although the planer form tries to say that there is a plane of symmetry but that is not possible because this is axial, this equatorial, so plane of symmetry is there. So, that is the problem with the planer form it can give you wrong notion no plane of symmetry.

However, some symmetry is there and that is the centre of symmetry because you see that central point whatever atoms if this is a centre of symmetry, so there is I present here, if that be the case, then it should be perfect meso then it should be perfect meso, so even if you try to suppose you have overlooked that presence of I or you have you are actually adopting the very basic premise that I will draw the mirror image and I will try to see whether they are superimposable or not, that is the (())(40:49) approach to find out the superimposablility or optical activity of a molecule.

So, draw the mirror image, this is the ring B and your ring A will be this is your a C ring and your A ring will be on this side, this is your A ring, put the hydrogen's, the hydrogen here hydrogen there, hydrogen there, hydrogen there. So, now adopt that the demonic whatever we have learnt, so we go from 11, 12, 13, 14, let us take that approach, so hydrogen at 11 is again I repeat this relationship axial equatorial beta alpha everything with respect to the B ring.

So, this is axial equatorial axial equatorial the nature is beta beta alpha alpha and then your direction is clockwise, the direction is clockwise and here if you do the same thing, so here that will be you have to have axial equatorial axial equatorial then axial equatorial. Now axial equatorial I have gone from here then come there 11, 12, 13, 14, I could have done another way, where maintaining these two same like axial 13, 14, axial equatorial and no this is different that is alpha alpha and this is beta beta.

Now, there is a difference you might have thought that I will go from 13 14 and then 11 12, but that is not same, because you are changing the alpha beta natation. So, this is axial equatorial axial equatorial keep that as beta beta alpha alpha, now this is okay axial then you have to find out where is your axial, your axial is here axial equatorial so beta beta alpha and alpha, beta beta alpha alpha and the relationship (())(43:16).

So, this is the situation we are trying to compare this two and here we decide to go from an axial or demonic says that you first fix out the axial equatorial nature so we will do that, axial equatorial axial equatorial axial equatorial axial equatorial, then it could be beta beta alpha alpha however here there is little we have to be extra careful because this axial equatorial axial equatorial can also be achieved by starting from 13 hydrogen going to 14 and then 11 and 12.

So, that is also axial equatorial axial equatorial that we have to remember, so when we write this because there are two possible ways of achieving these axial equatorial axial equatorial, so if you fix this as your reference point starting point and suppose I now see our alpha beta nature basically we are looking from the top and that that gives us that this is a beta these two are beta these two are alpha.

Suppose I look from the bottom change the reference plane that means I look from the bottom then what will be earlier alpha that will be beta, what will be earlier beta that will be alpha and then alpha becomes beta, beta becomes alpha, alpha becomes beta, but axial equatorial remain the same, so if I look from the bottom change the reference plane, then what will happen that this will be again axial equatorial axial equatorial, but I can get another version of this then this will be beta this will be beta that will be alpha this will be alpha that will be alpha because I am looking from the from the bottom from below and changing my reference. So, the below bonds are now beta and the above bonds are now alpha.

So, what will be the direction now, apparently whatever direction you see from the top it will be just the opposite when you look from the bottom, so now my I am starting from 13 14 11 12, so this looks like that this is going in a clockwise direction, but actually that will be anti. So, you have to do both here.

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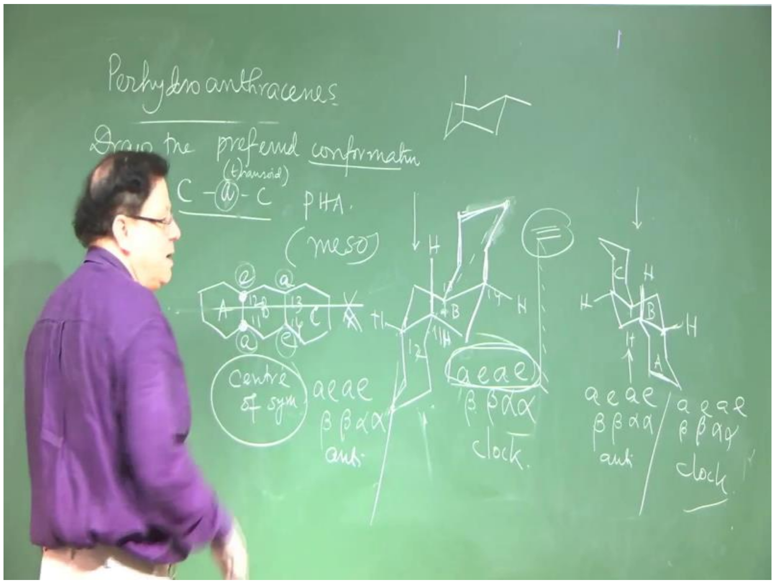

So, similarly you do both for this molecule, so what will happen you fix this axial equatorial axial equatorial. However as I said there are two possibilities that this is your this could be your beta, now my reference plane is from the top, so I have seen from the tops of beta beta and then alpha alpha and the direction is anti and if you look from the and if you look from the if you change the reference plane that I look from the bottom and then I can start from this one axial equatorial and then axial equatorial, if I do that and then you see then this will be beta beta alpha alpha and apparently the direction is anti but that becomes clockwise because I am seeing from the bottom.

So, whatever way you do, you see that there is similarity here, you this one becomes similar to that one, axial equatorial axial equatorial beta beta alpha alpha this is clockwise or you can compare these two also that becomes identical in that one. So, basically these two are identical with each other, so that actually this is a special molecule where you have to be extra careful to adopt this mnemonic otherwise you may land into problem.

If you can see the I vary this inversion point then is well and good otherwise adopting this you have to be extra careful because as I said this axial equatorial axial equatorial can be achieved in two ways here, because of the that symmetry that it is a 4A system AAAA system, so that created all the trouble and you have to be extra careful in comparing these two, so they become similar they are same actually, so that means it is a true meso,

However, again just repeat that said that there is no plane of symmetry what is present is a centre of symmetry, what is present centre of symmetry and overall contribution remain the same that it is a meso compound, but your justification for having this molecule in the meso form is completely wrong if you compare the planer form.

I think that takes care of the tricyclics system, so we have gone through the perhydrophenanthrene in this session of the lecture, perhydroanthracene because it belongs to a 4A system, so it has actually least number of isomers, so ultimately what happened that it has 2 dl pairs, it exists as 2 dl pairs and 3 meso forms. There are several important issues that are while you consider the number of stereoisomers in perhydroanthracene and also its optical activity that one important thing that because of the symmetry present here, so two things become similar like this cis syn and trans and cis anti and trans they are basically representing the same diastereomers.

So, that truncates one number we have 2 dl pairs and then 3 meso forms, earlier was for perhydrophenanthrene 4 dl pairs and 2 meso forms, so number of meso forms got increased, the number of isomers got decrease that will always happen when you have increasing the number of meso forms. And we have now we know how to draw the different conformations of these various stereoisomers the trick is that write the B form and also assign the axial equatorial orientation in the planner form and then convert it into that (())(50:36) form that means the non-planer form the actual conformation.

So, I think that takes care of these perhydrophenanthrene and perhydroanthracene, so thank you very much, next day we will do it will be a problem solving session, so we will have different problems solve and we will solve that that. So far we have gone through the cause of stereoisomers, then the point group point group the symmetry point groups the symmetry number then the order of symmetry and then we have done the absolute configuration of chiral axial chirality containing molecules or the planer chirality containing molecules and then and the helical chirality then we have done the bicyclic system by bicyclic cyclic system and the tricyclics cyclic system. So, we will do the next class we will do the problem solving. Thank you.