Course on Stereochemistry
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Module No 02
Lecture 09: Problems on Absolute Configuration

Okay last time we have seen the how to assign the RS contributing to a molecule okay? Again I just repeat before I go into solving some problems that in the RS system what you have to do is that you have to place yourself in such a way that you look at the stereogenic carbon and so that the 4th, the group of the least priority is away from the observer and then you see what is the sequence if you go from 1 to 2 to 3.

If it is clockwise direction, then that is called R configuration, if it is in the anticlockwise direction, 1 to 2 to 3, then that is called S configuration okay? Now let us do, practice few problems, 1 or 2 problems, before they go into the next topic.

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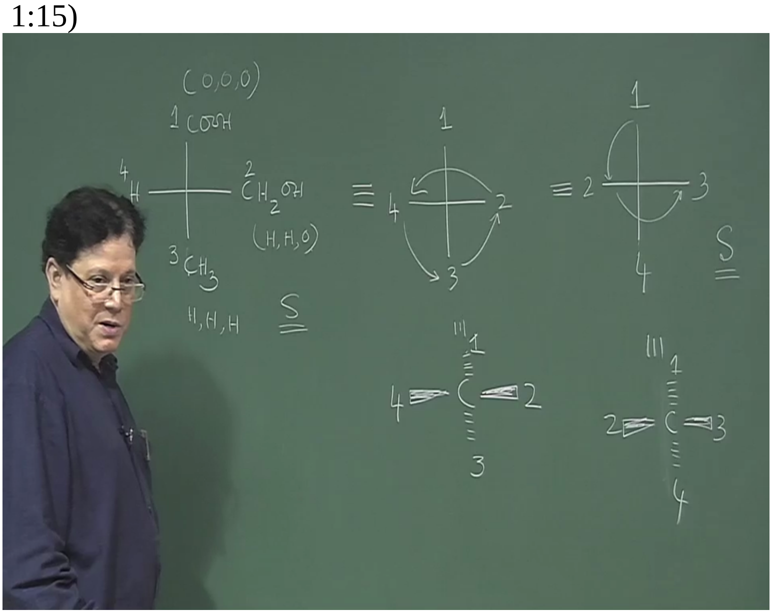

Suppose a molecule is written in a Fisher projection formula, say this is CO2H, this is CH20H and this is H sorry this is H and this is M methyl and you are asked to assign the absolute configuration or the RS configuration of this okay? So when you are trying to solve this problem, the 1st thing you need to do is to assign the priority sequence of the groups okay? So if you do the priority sequence, this is the 1st atom, the carbon, this is also carbon.

So there is no distinction, let us see whether there is any distinction between this and that. You can find the distinction because this carbon is attached to only one oxygen. So that means, this carbon is having hydrogen hydrogen oxygen, this carbon is having, this is, remember this is C double bond O and OH. So this carbon is having 3 oxygens basically because C double bond O means you have to add one more oxygen to the carbon.

So 3 oxygens. So that and this is methyl, only 3 hydrogens and this is only hydrogen. So assigning the priority is becomes little easier now because the difference you find in the 1st atom that is attached to the stereogenic centre. So this is number 1, this is number 2, this is number 3 and this is number 4. Now some books, you will find that they are written like A, B, C, D. That is also permissible. So then you have to say that going from A to B to C what is the directionality okay? So then after assigning the priority sequence, you write in a simpler form, do not write the groups.

Just say that number 1 group is here, number 2 is here, number 3 is here, number 4 is here okay? And now see what, try to find out that what is the configuration. Now here, the there is a slight problem because in Fisher projection, you know if you convert it into the OH formula then these 2 horizontal bonds are beta and vertical bonds are alpha. That means this is number 1, this is number 2, this is number 3, this is number 4.

So if I am looking from here, that means we are the observer from in this side. So I am actually looking from the side of the 4th group. But in order to assign the RS configuration, I have to look away from the side of the group number 4. Now how to deal with this situation? Now it is up to you what you want to do. There are different ways people can direct assign the RS configuration. Some people do like this that you know that exchange in a group of 3 is allowed.

So what you need is to bring the 4th group either in the in the income of the vertical positions by exchange in a group of 3. So if you do that, bring for here, 3 there and 2 there so that if you do that, you do not change the molecule because that is according to the rule of Fisher projection, that is allowed. So you do that and this becomes 4, that becomes 3, and that becomes 2. So it is a same molecule but now, the beauty is that the 4th group is in the alpha position.

So if that this in the alpha position, that means what you see is, so if you convert it again into the OH formula, you will see that it is in the right perspective that the 4th group is away from you. So if the 4th group is away from you, then what you see from the top, from here is 1 to 2 to 3, the direction is the actual direction that you should you should is the direction that gives the correct configuration.

Or to to tell in another way that now if you see from this side, the molecule is held in the correct formula where the 4th group is away from you. It is alpha. That means it is away from you. So now what is the configuration of this system? 1 to 2 to 3. So that means it is in the anticlockwise sense. So this is the S configuration. So the result is that this molecule that was drawn to, it was in the S configuration okay?

Some people avoid this exchange. Now this is what is called this is the original one which is called the very good rule. That means, what you do, that if the 4th group is not in occupying the the vertical position, you bring it in the vertical position and then whatever you see, that gives you the R or S configuration okay? The other way to do it is that do not do any changes. Just whatever is there, you just keep it there.

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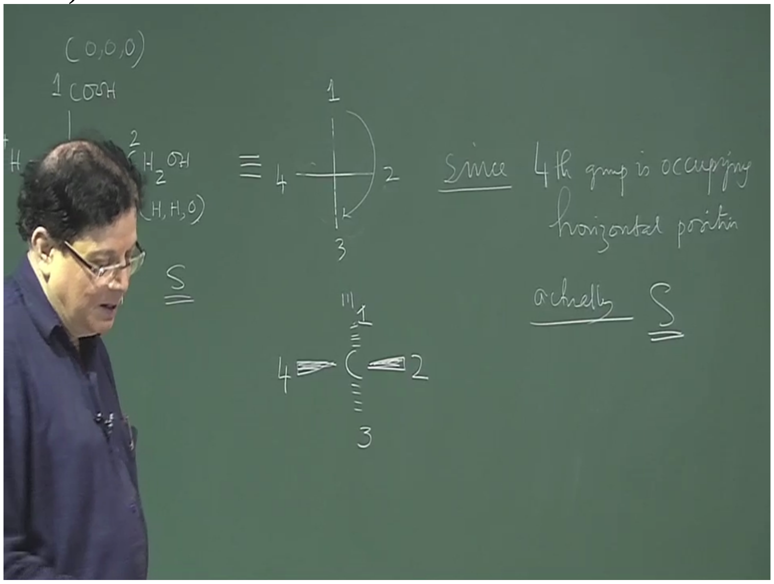

So basically, this was our structure. The 4th group is now occupying a direction which is towards the observer. Now remember that the very simple thing is that if I rotate, if I see a rotation, if I see the say clock, the clock rotates in the clockwise direction. That is where the name has originated okay? The clockwise sense. But if I look if I could have looked that clock from the backside of the clock, then what I will see is that the clock is moving in the, the hands of the clocks are moving in the anticlockwise direction.

That means if I see the molecule but the 4th group is away from me if the direction 1 to 2 to 3 is clockwise, then if the 4th group is towards me, that clockwise will become anticlockwise. Like if there is a fan rotating in the ceiling and if you see from the bottom, the fan is rotating in a clockwise direction. If somebody looks from the floor the same fan, to him or her, it will appear anticlockwise. So if you remember that, then there is no problem.

Your 4th group is here towards the observer. Now the 1 to 2 to 3 is the clockwise direction but you remember that basically the 4th group is in the is towards you. So whatever you see, you actually reverse the reverse the direction. So basically, 1 to 2 to 3 is in the clockwise sense but since but you have to write this when you write an answer, since 4th group is occupying horizontal position.

So actually the configuration should be S. So whatever it appears, you just reverse it okay? So it is up to you what you want to do. If you want to bring the 4th group in the vertical position, you do that. Otherwise, you can keep it in the horizontal position but then remember whatever you see keeping at the horizontal position, we have to reverse the direction okay? So that is the RS.

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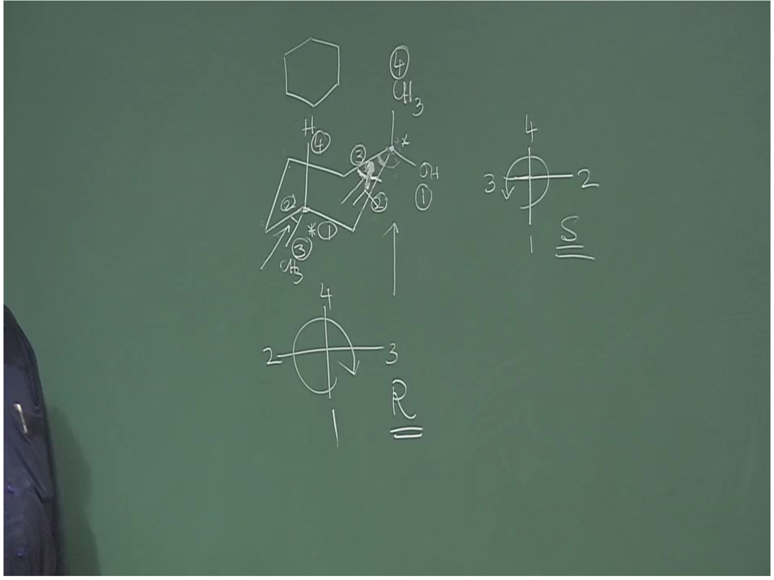

We can actually do more problems but I think the some other cases I tell you where you might face some problem is we will we will go to this section later on but you know what is the molecule cyclohexane? The cyclohexane is the planar form is the we write it in the planar form but actually this exists in the in mostly in the chair form okay? Mostly in the chair form. And suppose there are 2 groups, here there is a methyl, there is a OH and suppose there is a methyl here.

Now this molecule has two stereogenic centres, one is here, another is there. And if I ask now to do the absolute configuration of this carbon, absolute configuration of this carbon, so what you do 1st, try to sign the priority. This carbon is attached to OH. So oxygen, this is attached to carbon, this is attached to carbon, this is attached to carbon. So this must be your number 1. And what is the number 2? Number 2 is this is the carbon CH 2, this is also CH 2.

So there is no difference here but then the next carbon going from this side is the carbon attached to 2 carbons. Here, this carbon is attached only one carbon. So this gets preference, that means this is your number 2, that is your number 3 and this is your number 4. So now, how to assign the configuration. Now again if you are very good, if you have good concept about three-dimensional structures, because you have to look from this side and then see what is the direction going on 1 to 2 to 3 okay?

You can do that. Those who can see it visually very clearly, they can tell what is this direction 1 to 2 to 3. But I can give you some protocol mnemonic devices. Mnemonic devices means some simple way of doing this. Those who cannot visualise very well, a three-dimensional structure, for them this rule you can apply. These are mnemonic. This is not a rule.

This is this is just for the sake of, these are called mnemonic device. So that you do not have to think a much but you can arrive at the right answer without going into the complexity of the three-dimensional structure. So what is this mnemonic mnemonic device? That what you do in cyclohexane, when you write the chair form, interestingly some angles appear bigger than the others although all are angles have 109 degree 28 minutes, but some angles to look because this is a two-dimensional perspective formula.

So some angles will look like smaller than the others okay? So this one looks the the smallest amongst all these 4 angles. So the mnemonic devices that you look into the system, standing in between the bonds which makes which appears to make the smallest angle okay? That means I am standing here. See if I stand here, then what happens? These 2 bonds or towards me and towards my right hand, left-hand.

And this is sorry I am sorry I am actually standing, I am standing here, in between this okay? So this is my position and I I, this my position of the 2 hands okay? Suppose this is a person okay? These are the hands, these are the legs okay? So this is the right-hand, this is the left-hand is the head and this is the leg okay? So I look, I stand here. If this happened to be me, I stand here and then I look at this carbon.

So if I do that, what happens? These 2 bonds are towards my hands and towards me and these 2 bonds are away from me and their occupying, one is going towards head and the other is going towards my leg okay? So now you can easily draw the Fisher projection directly. Without doing the atoms, better draw the priorities that we have already assigned. So which one is the number?

Number 2 will go towards my right hand, number 3 will go towards my left-hand, number 4 will be at the top, number 1 at the bottom. Okay? So you stand, the rule is that the mnemonic cool rule is that you stand in between the bonds which appear to make the smallest angle but again I repeat, this is all the angles are 109 degree 28 minutes but when you draw it in the Fisher, in the two-dimensional projection, it appears that one angle is very small.

So now, you stand in between, spread your hands and it looks like, just like the Fisher projection and the way it should be in the Fisher projection and you draw the Fisher projection. So on the right is 2, left is 3, 4 is at the top, one is at the bottom okay? Now since 4 is occupying the horizontal the vertical axis, so whatever you see, that will be your configuration. So it is anticlockwise, that means this is S configuration.

So if you want to do the configuration of this now, this carbon, this is the other carbon, so according to that mnemonic rule, through which you should see, this angle appears to be the smallest. So you stand here and look from there. If you look from there, 1st assign the priority, this is the carbon. This is a carbon, there is no difference because this is CH 2, that is CH 2. But then, you find a difference, CHOH.

So this should be 1, that should be 2, that should be 3 and that is before. So if you do that now you look from this site, it looks, it is just the way it should be in the Fisher projection. So you ride the Fisher projection. On the right side is 3, on the left side is 2, on the left side is 4, on the bottom sorry 4 and on the bottom side is 1 okay? Again 4 is occupying the vertical position.

So you do not have to change anything because it is now away from the Observer. So whatever you see, 1 to 2 to 3 is the correct designation. So it is R, you do not have to invert it okay? So this is some of the tricky situations specially in cyclohexane system when it is written in this form.

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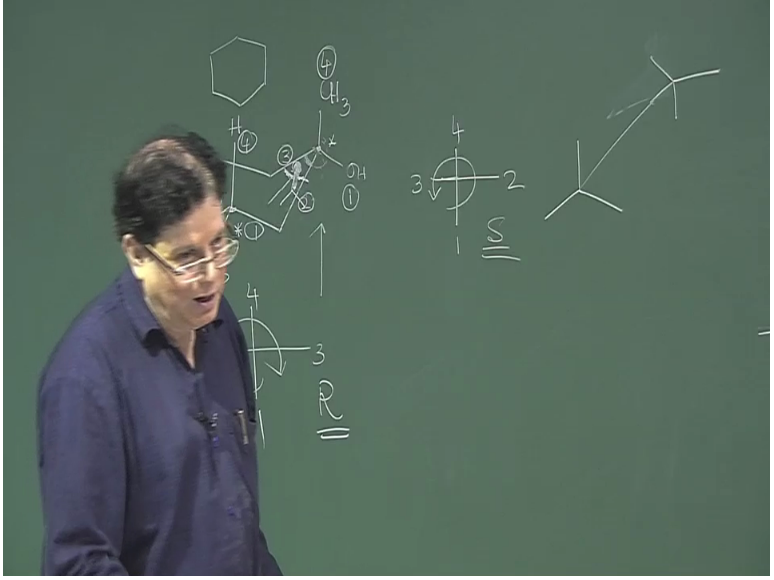

Or in the it the same thing will happen in if you draw it in the sawhorse also. Sorry if you if you try to draw it in the sawhorse formula, the same thing will be applicable. So what I say that you always see it in a fashion which gives the lowest angle okay? So that is a kind of mnemonical. There is a if there is no hard and fast rule that you have to do it but I think for beginner, for students who are at the beginner stage, for them this will be very helpful okay? Now let us go away from this RS. So we said that we will also do the relative configuration.

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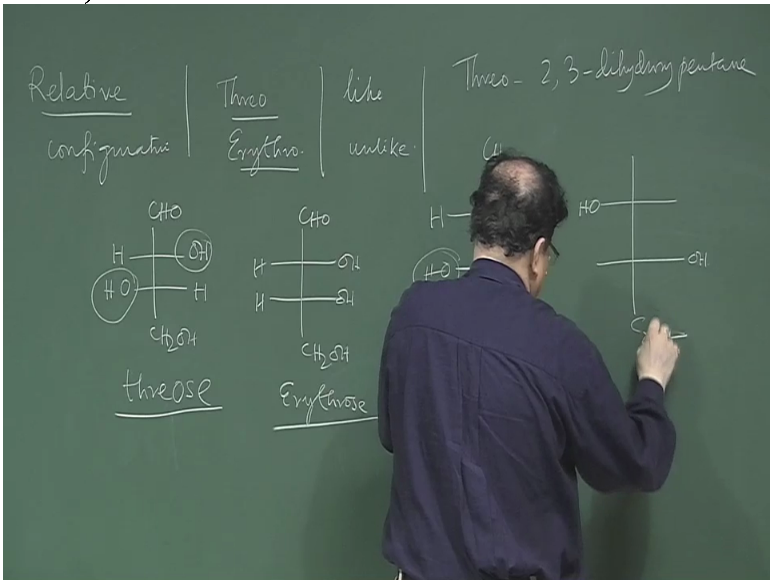

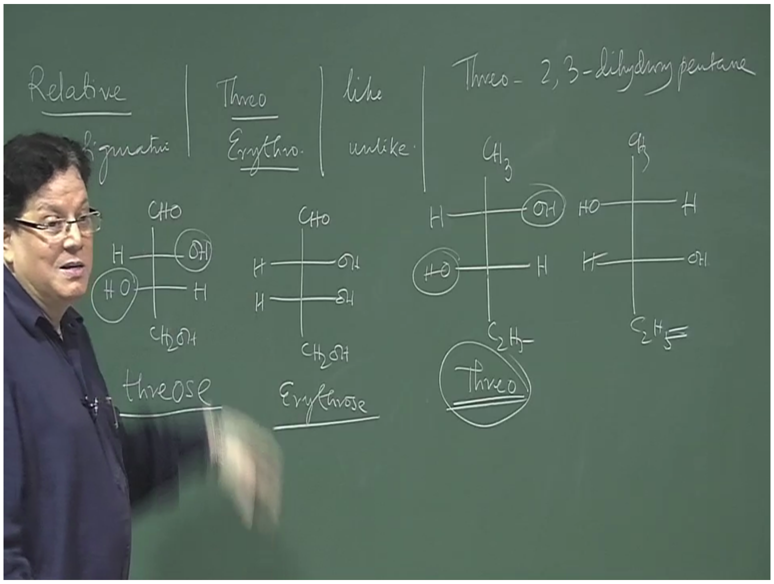

Relative configuration again I say, there are 2 types of relative configuration, one is that if you do not know the configuration, absolute configuration of a molecule, you try to go relative. That means, you convert one molecule which is of known absolute configuration into your target molecule for which you are trying to determine the configuration. Then if you can convert that, then you say that okay, it has got this configuration because it is, it has come from the original compound for which the configuration is known but this is actually the relative configuration because there is no direct proof, direct x-ray crystallographic proof for the configuration of the other molecule.

That I have explained earlier. Another type of relative configuration I said were there are multi-stereogenic systems. Then the relative configuration is is basically the the configuration, configurational relationship between the 2 stereogenic centres. Like suppose, one stereogenic Centre is R, another is S, so or this is R, this is S, this is R. So that means, they have opposite configurations.

If that is the case, then the situation becomes a case of relative configuration that if I say that droid tartaric acid where the 2 stereogenic centres have opposite configurations, so these oppose configurations mean that I am talking about the configuration of one in relation to the other okay? Again there are nomenclature systems for relative configuration and that started from again the carbohydrate.

You remember the DL nomenclature system started from the carbohydrates that Emile Fisher resumed that + glucose in the D configuration and he said, what is D? The the last stereogenic Centre if the OH is on the right, then that will be called the deconfiguration okay? That is just an assumption. Fortunately, when the x-ray crystallography was done, it was found that Fisher was right. So whatever structures he had given for other aldohexoses, other carbohydrates were all right.

But if it was he was wrong, then the literature had to correct all the structures what he had given based on the configuration of + glucose. But fortunately, it was found later on by crystallography that Fisher was right in his assumption. But that is purely a coincidence okay? Now this relative configuration, there are different ways to to designate relative configuration. One is called Threo Eryhreo. So what you? Then another is called like unlike.

We will not we will discuss only few. There are many ways to describe this configurations, relative configurations. What is a Threo configuration? The Threo configuration is that take this carbohydrate at this sugar molecule. The sugar molecules are basically the poly hydroxy aldehydes okay? So if you see that the this OH groups are opposite to each other in the Fisher projection formula, then that is called Threo. Actually this molecule is what is called Threos.

And the molecule where both the OHes are on the same side, that is called Eryhreos that is called Eryhreos. And based on this, if I draw a molecule which has got suppose this is OH here, this is CH 3, this is C2H5, this is OH here, this is H here, this is H here, this is not Threos or Eryhreos, this is a different molecule. But because this OHes on the opposite side, so that will be called a Threo molecule, Threo and then IUPAC nomenclature whatever.

This is actually 23 dihydroxy pentane. So Threo 23 dihydroxy pentane. Threo 23 dihydroxy pentane. So you can write the but remember, if I ask somebody to write the structure of Threo 23 dihydroxy pentane, here she has to write two compounds for this, 2 structures for this. And you cannot because this one is also Threo, both are free of because in both the cases, OHes are on the opposite side, OHes are on the opposite side okay?

So that is , this is Threo. So in a Eryhreos, both the OHes are on the same side. So again if I ask you to write erythreo 23 dihydroxy pentane, you have to write 2 compounds. That is why this is called relative configuration. See, this is not absolute. You cannot absolutely tell which one is the compounded you are talking about. Okay? So this is Threo Eryhreo. There is another one which was that introduced by a Swiss chemist, his name is Sevak. Sevak gave another way of of giving a nomenclature, relative nomenclature for relative configuration.

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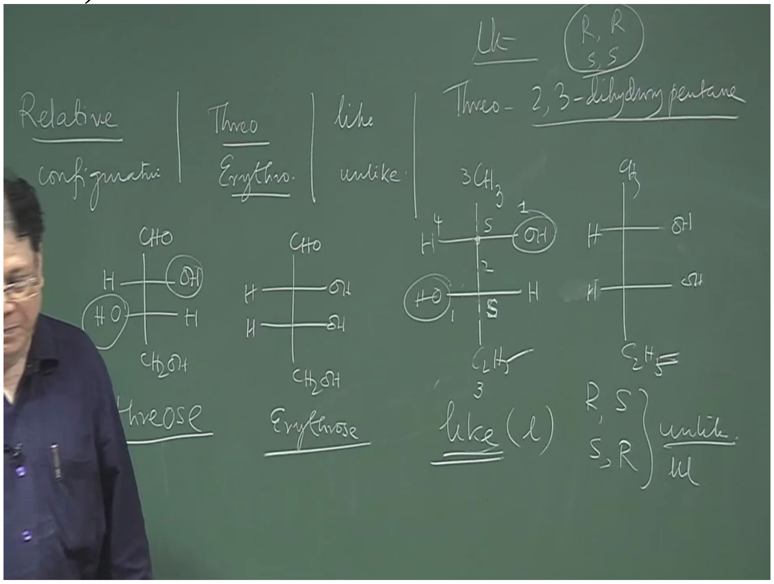

See the problem with this Threo Eryhreo is that if you do not have this OH, suppose you have some other group, say this is chlorine and suppose this is C3H7, then which one is Threo, which one is Eryhreo? That is a problem. So unless you have hetero atoms like OHes or suppose 2 chlorines, that is still okay. But this is mainly, Threo Eryhreo is mainly applicable for this 0Hes.

So if you do not have 0Hes, if you have alkyl groups, all alkyl groups or other or other groups, say chlorine, then another, fluorine, then it is very difficult. You cannot actually assign Threo Eryhreo to the system. So Threo Eryhreo is not a general, general nomenclature system for relative configuration. So realising that, Sevak gave Sevak gave another another way to designate the relative configuration. And what is that? C., I go back to the original molecule.

Suppose I have 2 molecules, OH, H. In the Threo Eryhreo system, this is the Threo compound and this is the Eryhreo compound because the 2 OHes are there.

In Sevak system, what he says? That you determine the RS configuration of this RS configuration. So what is the configuration of this carbon? So this is 1, that is 2, this is 3 and this is 4. 4 is occupying the horizontal line. So you have to be careful. So what is the configuration here? 1, 2, 3. So that means, this is actually S. Although it looks like clockwise but hydrogen is on the horizontal side, so this is S. What is here?

This is 1, this is 2, this is 3 and this is 4. So here, again a hydrogen is occupying the horizontal line. So whatever you see, you have to reverse it. So 123 is clockwise but actually it should be anticlockwise. So this has got AS configuration okay? So now he says that in the configurations of the 2 centres are similar like SS or RR then that will be called like systems okay? And if the configurations are different like RS or SR then that is called unlike system.

So, see you do not have to write all those 6 letters. You just write, U is unlike, UL and this, you write only L, like. So instead of 3 Eryhreo, now he says that do the absolute configuration. So if I say that write the structure of like like, that means L 23 dihydroxy pentane, actually LK, I think like is LK possibly, unlike is UL.or write full name. So write the structure of like 23 dihydroxy pentane.

So that means, whatever I write this 23 dihydroxy should have RR or SS configuration. Earlier it was Theo Ertythrop, now it is like unlike okay? I will clarify this weather what is the convention, whether it is right LK or only L because L has this liver rotatory thing in mind. So possibly this is LK and that is unlike, that is UL okay? That is unlike.

So this is the these are the 2 nomenclature systems for relative configuration. So what is the difference between absolute and relative? Absolute means, you write only one molecule, in relative, you have to write 2 systems need in multi-stereogenic Centre okay.