Course on Stereochemistry
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Module No 02
Lecture 05: Newman and Saw Horse Projection and Wedge Representation

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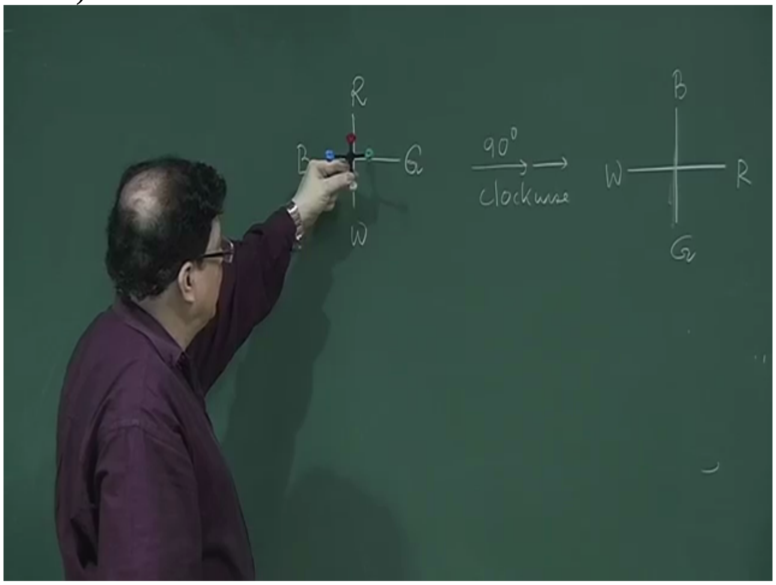

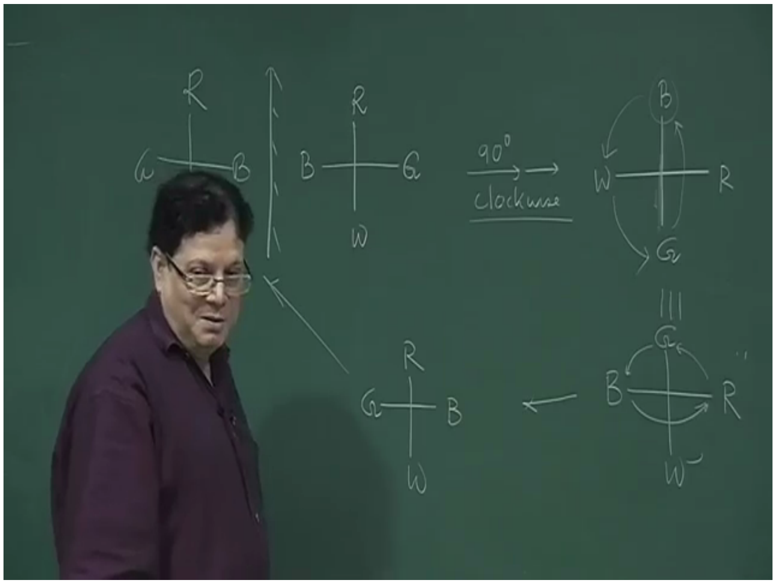

Okay welcome back. Now last time, we just introduced you to the Fischer projection formula and I gave you certain rules for maintaining the integrity of the formula that you cannot rotate or change the position of the groups or interchange the position of the substituents at your will.

There are certain rules. One, I said that 90 degree rotation is not permissible, whether clockwise or anticlockwise. Now suppose I take a molecule like this.

Let us see which one fits to it. So I have to I have drawn the the Fischer position formal of this molecule. So you see that I am holding it that what it is supposed to be when I observe from here, these 2 are towards me and these 2, the vertical bonds are away from me and then I draw the projection on the plane, on the reference plane. So I have red on the Jack green on the right, blue on the left, red on the top and white at the bottom.

This is the molecule. Now I am rotating the see if I rotate this molecule by 90 degrees it does not matter. It remains the same. But because it is a three-dimensional position formula of this, I have to follow certain rules. I said 90 degree clockwise rotation or anticlockwise rotation is not possible. So what happens there if I do that? So I just give an example that I do a 90 degree clockwise rotation, so R comes here, green goes there, W comes there and B goes there.

So what is the relationship between these 2? Now I gave you one rule that exchange in a group of 3 is permissible. So let us try to match by this exchange in a group of free. So how do I do? Because everyone has changed their position, so I have to slowly bring them to their normal position what ails here. So if I try to bring B here, then blue will come here but I have to do another exchange in a group of 3.

So W has to go there. So W comes here because the way I am doing it, so the 2 groups at least come in the respective positions if I do that. But then G has to come to the position of B. Okay, this is exchange in a group of 3, that is allowed. So now what is happening? This is equivalent to, this is B, so this is B, this is W, this is G and this is R okay? Now what remains?

There remains that the now you cannot see you have the W here, W there, you have B here, the only problem is you have G and R there interchanged with each other. And as I said, one if you want to know interchange these 2 positions, that is not allowed. So what I do? I do again another exchange in a group of 3 and it will be interesting. If I do that, then B will be here, keep the W there and R will be at the top and G will be at the bottom.

Now look at these 2 molecules. If I put it here, unfortunately it is actually drawn in the down, in the bottom but if I place it on this side or if I place it on that side maybe I can draw it again. The same thing I point. So B is here, G is there, R is here and W is here. So what is the relationship between these 2? Now you see that they are Enatiomers of each other. That means if you do this 90 degree clockwise rotation of a molecule with a single asymmetric carbon or chiral centre, that what happens that you change the molecule into the Enatiomer okay? So likewise you can in this way you can prove the other other restrictions or the allowable operations that are Jack that are there in the Fischer projection formula in the same way.

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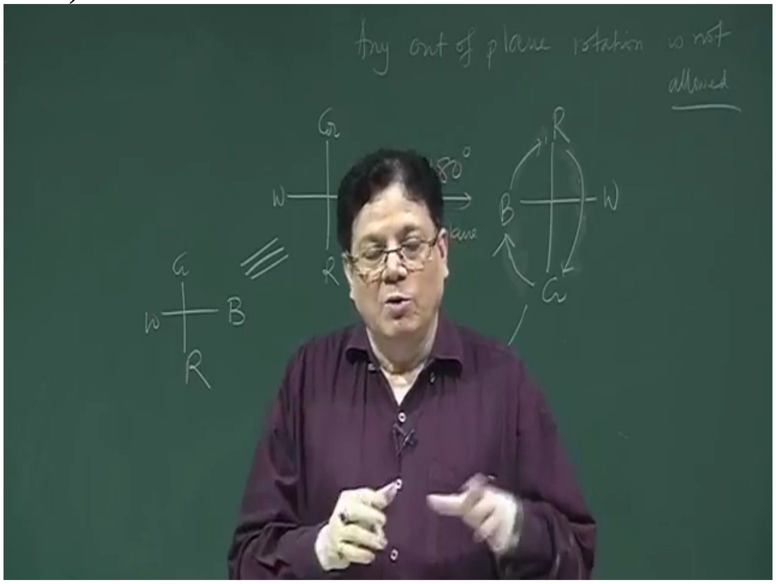

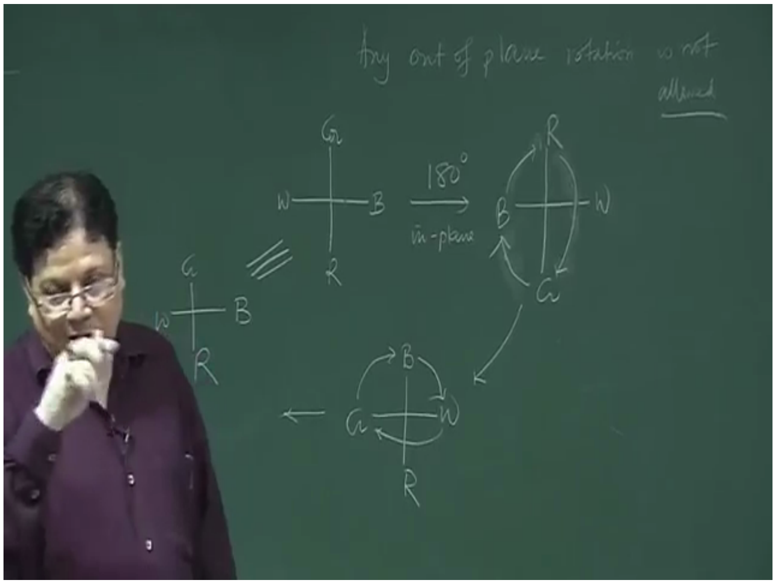

Like the other one I can do the say they the other one that what I said that 180 degree rotation is allowed okay? So why I draw the same thing. This is now blue, this is white, this is green and this is your red. So if I do 180 degree in plane rotation, so G will be there and R will be here and B will be there and W will be here okay? That is 180 degree in plane rotation. Now if we want to compare these 2, what we need to do? We again want to try to bring the groups in the respective positions okay? So R was down. So what I will do? I will change R, bring R here and then I bring G there and I put B there okay?

So now sorry what happens? R goes here sorry maybe it will be the other way around because I want to put the G Jack okay I want to put R here. So R here, G here and B here. So if you do that, so what will happen? So here, it will be R, here, it will be G and here it will be B and W remains at the same position. At least R has come to the place where it was originally. Now I do another exchange in a group of 3.

So I bring G here, I bring B here and I bring W here. So if you do that, you see that B is here, then W is here, and G is here, R is there. Now compare these 2. They are the same. R is here. So they are the same molecules. That means 180 degree in plane rotation is allowed. 180 degree out of plain rotation is not allowed because what you do is, you change the because these 2 points are towards you. So if you do a 180 degree out of plane rotation, you are disturbing the Fischer position, the basic premise of the Fischer projection.

These 2 bonds will become alpha and these 2 bonds were earlier alpha, that means the dotted ones, away from the board but if you rotate it by out of plane, so they will come towards you. So you are basic you have violated the basic principle of Fischer projection. So that is why any out of plane rotation is not allowed in Fischer projection. So I can write it, any out of plane rotation is not allowed and the simple reason is that you disturb the alpha beta the that above the plane or below the plane.

I should have mentioned it earlier, when you darken the line, that is designated as beta and when you dotted the line, that is designated as alpha. So the Alpha beta nature like these 2 are should be beta in the Fischer projection but as you lift it up and bring it out of the plane, the alpha beta nature gets disturbed. So that you cannot do. That is why, those rules were framed in Fischer projection.

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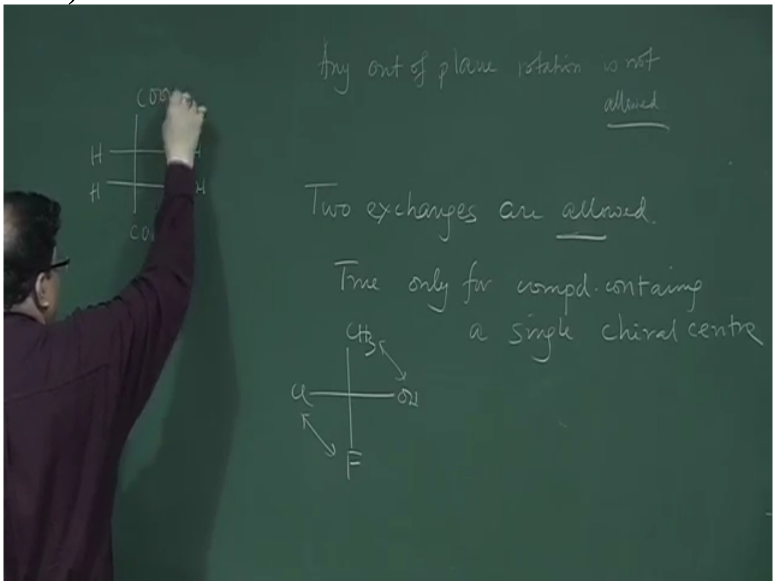
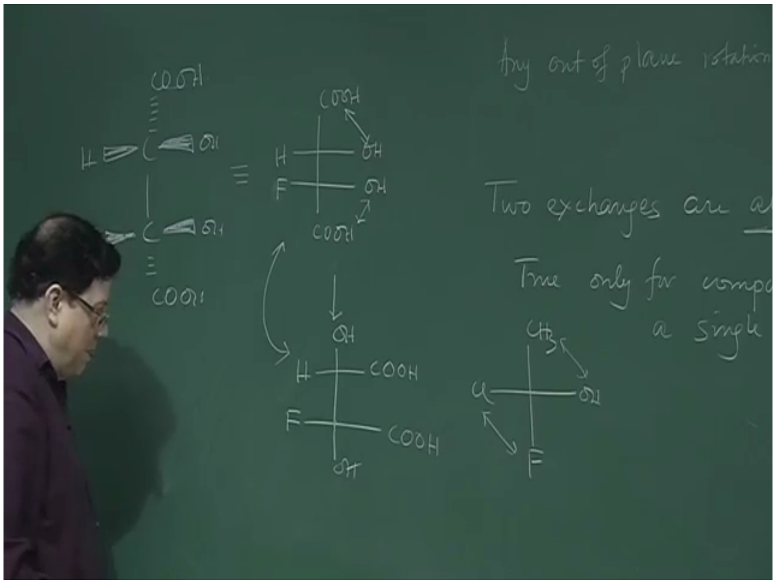

Any out of plane rotation is not allowed

Two exchanges are allowed.

True only for compd. containing a single chiral centre


Any out of plane rotation

Two exchanges are a

True only for compd

a single

Another is question that may come in mind because in several books, it may be written that 2 exchanges are allowed in Fischer projection, 2 exchanges are allowed. Now this is true only for, true only for compound containing a single chiral centre. This is only applicable for a compound containing a single chiral centre. That means, if you again have say suppose the methyl, OH, chlorine, fluorine, if you do to exchanges, that means not in exchange in a group of 3.

See if I interchange the position of this and that, if I interchange the position of this and this, that is allowed okay? But I did not mention it as a general rule because in general, it is only restricted for a single chiral centre (())(10:10). When the chiral centre increases, this rule will fall apart. I can give you an example. Suppose tartaric acid, if I write tartaric acid, OH, OH, CO2H, H, this is the Fischer projection formula of tartaric acid.

Now if I ask you to convert it into the OH formula, you can that means the OH formula is, carbon this is the beta bond OH, this is the beta bond H, this is carbon, this is the beta bond OH, this is the beta bond H, this is COOH and this is COOH. This is the OH formula okay? Now as I said, if you do two exchanges now here in this molecule, suppose I change this one, the OH with CO2H and I do change the so OH comes here, COOH comes there, H comes here and I do another exchange where OH comes here, CO2H comes there.

This molecule, this is not the right example. Maybe I can take I I think I change this a little bit into another system, say fluorine okay? So replace this hydrogen with a fluorine. So the fluorine now stays there. So it is a, it is not a tartaric at it. It is now a fluoro derivative of tartaric acid. I draw the Fischer projection, I do two exchanges, the OH and CO2H and here, the OH and CO2H and what will happen? That you can try at home that these 2 now becomes diasteromers.

They are no longer the same molecules although we have done two exchanges. The interesting point is these 2 exchanges you have done on 2 different carbon centres, 2 different chiral centres okay? So the actual if you want to stick to this 2 exchange rule, you have to say that 2 exchanges at the particular chiral centre is allowed. But 2 exchanges at different chiral centres will lead to diasteromers okay?

You can through problem-solving Jack approach later on, we can clarify the doubts here, if somebody has any doubt, this can be verified by working out several problems okay? So this is all about Fischer projection. Now there are other problems as I said.

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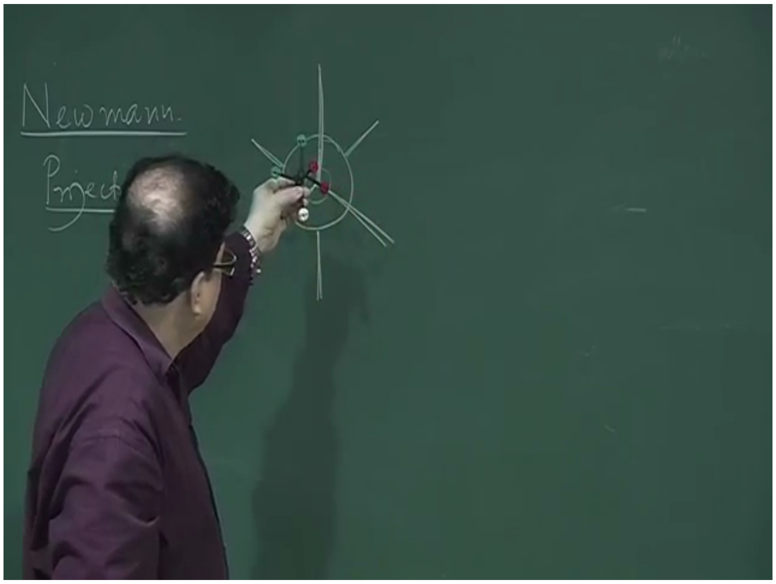

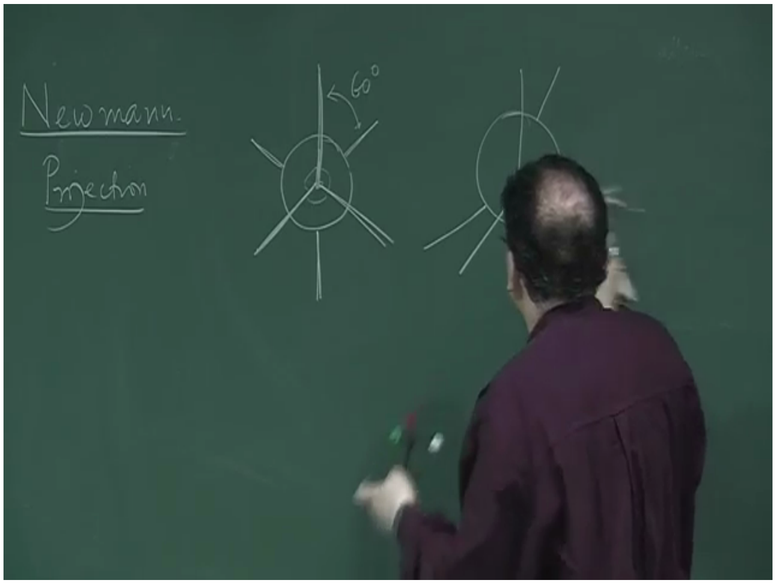

The 2nd one is what is called a Newman projection, Newman projection formula. Now in Newman projection what you do, this is not for a single carbon containing compound. This Newman projection is usually two carbon containing compounds that if you have two carbons joined to each other and then in Fischer projection what you do? You hold it in such a way so that the horizontal bonds face to you. Then you can draw the Fischer projections straightaway.

In Newman projection, rather than looking from this direction, what you do? You turn the molecule in this direction and then try to see from the carbon carbon axis. So if you see from the carbon carbon axis, basically this carbon is is not allowing to visualise the other carbon. So that is blanked out by this front carbon. So this is the front carbon, this is the back carbon and this we, in Newman projection, this is denoted as a dot for the front carbon and a circle for the back carbon.

And in the front carbon, now you have so the carbon carbon axis is basically you cannot show because this carbon carbon axis, this carbon is blanking out the other carbon. It is exactly in the line of your vision. But what you have? That in the front carbon, you have 3 bonds apart from the carbon carbon axis which cannot be shown. And in the back carbon, you also have 3 bonds. So now you take the projection of these bonds again a against a reference plane.

Suppose I have a reference plane here in the board and I take the projection of all these bonds in the plane of the board. So what will happen? The front carbon is has 3 bonds. So you can have 3 bonds like this and if you look at this tetrahedral carbon, although the angle is 109 degree 28 minutes, but actually when you draw a projection, it will look like that they are having 120 degrees, that is in the projection again I repeat.

Actual angle is 109 degree 28 minutes. So now you can have 2 extreme cases. In one case, you can have the bonds, the the other bonds, that means the other carbon, the back carbon also had 3 bonds but because the back carbon is is blanked is cannot be seen due to the front carbon but what you can see is the the bonds. So the bonds to actually show that this is the back carbon, so you end the back carbon at the circumference of the back circle.

So these bonds belong to the back carbon and these bonds belong to the front carbon. So this is one extreme case where it looks like this when it looks like this. And there are another case, other cases, there are innumerable projections formula you can draw. That you can draw opposition which looks like this. Says angle is made. That is also possible but that is also a Newman projection formula.

The basic premise is that you hold it, you should see the molecule along the carbon carbon axis and then draw the projection and the way to the way to representative is at the front carbon is shown as a dot with 3 bonds and the back carbon is shown by the circle and the bonds aims at the circumference of the circle but actually they are joined. They also go up to that carbon which is not seen because we are seeing from the front okay?

Now there are extreme cases like you know in this case what is the dihedral angle between these? This is 60 degree, the dihedral angle between the plane containing these bonds is 60 degree. And there is another extreme conformation. These are called confirmation. I will come back to that confirmation, what are the confirmations? Confirmations are these, by rotation you are actually changing the dihedral angle between the between the several carbon containing groups.

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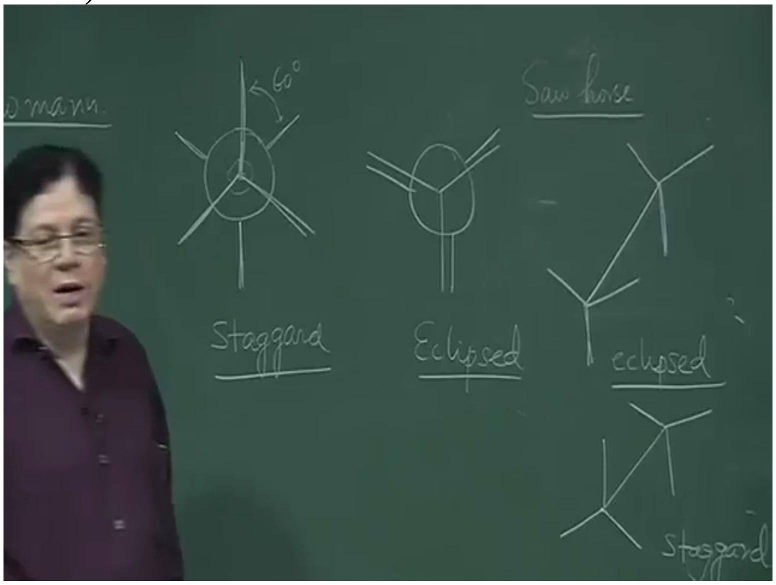

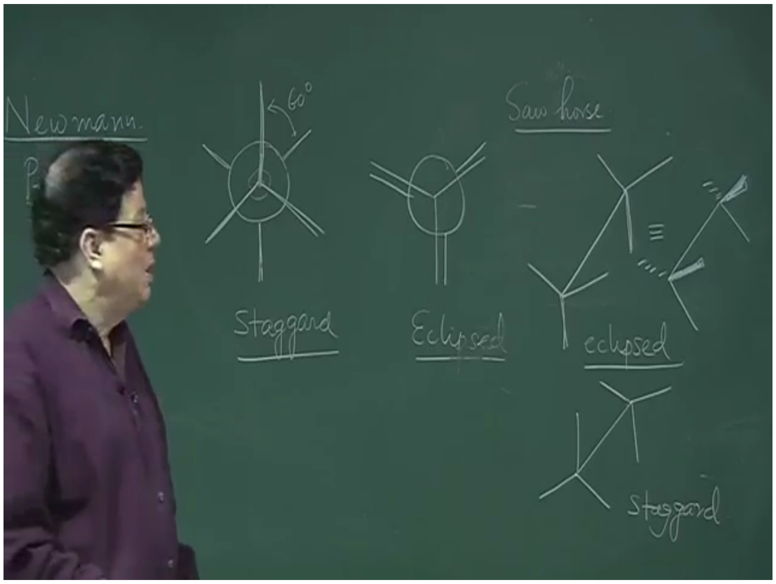

I am just drawing two extreme cases, the other one is that you can have another form which is, which will look like this. This is called the eclipse formula. You have to slightly shift it because otherwise actually this is perfectly this is actually blanked out by the front substituent. But in order to show it in the 2 dimensions, we just shift the bond a little so that these are these are visible okay? So this is what is Newman projection.

Now this this type of confirmation, again I repeat, confirmation is basically the innumerable innumerable Jack forms that you get by rotation around carbon carbon single bonds okay? So here we have drawn only 2 extreme confirmations. We will come back to confirmation concept later on. This is what is called staggered confirmation and this is the eclipsed, these 2 okay? Now there is (())(19:28) a 3rd one which is called saw horse, saw horse projection formula.

So what you do here? The carbon carbon bond is drawn in an angular version. Here, where the carbon carbon bond? The carbon carbon bond is actually is not seen because it is actually along the line of axis of viewing the system. In Fischer projection, the carbon carbon bond is visible because you are seeing it not along the carbon carbon axis. So that is why this carbon carbon bond is visible in Fischer projection.

In saw horse formula, you put it at an angle and then draw the other 3 bonds attached to it. So this is the carbon carbon bond and the other 3 bonds will look like this. So this is the saw horse representation where of a this bond is eclipsing this one. So that is the eclipsed one in saw horse. And what is the what is the other form? That means, the staggered form. You rotate one of these by 90 degrees, keep the top one maybe in the same position and the bottom one you rotate. So you get, if you rotate, that goes to the top, this comes here and that goes there.

So this is what is the staggered form okay? So basically what we have done till now in these past few lectures? That 1st of all, how to represent the three-dimensional molecule into the two dimensions. But you, Jack the 1st we started with that how tohow to use the wedge formula, the wedge formula actually is a three-dimensional, correct three-dimensional representation where the bonds are appropriately shown that whether they are above the plane or below the plane.

That is called the wedge formula but wedge formulas are little difficult to handle. That is why, that give rise to this concept of converting them into two-dimensional projection formulas. The 1st was Fischer projection which looks like this for a two chiral centre containing compound. Then we have the Newman projection where it is viewed along the carbon carbon axis and the 3rd one you have saw horse where the carbon carbon bond is is aligned, is drawn in an angular fashion and the other 3 bonds are then projected along the plane okay.

And you can have, see the problem can be given that how to convert a Fischer projection into a Newman projection or a saw horse or vice versa, the inter-conversion of all these things. Now one thing I should also write here that what is the more what is the wedge formula? If you convert it to the wedge formula, how will it look like? If you convert it to the wedge formula, then it will be that this bond is in the is in the plane of the board and this bond is also in the plane of the board.

And this will be beta and this bond will be alpha. And this bond will be beta and this bond will be alpha. This is the wedge formula, which conversion of this saw horse formula, saw horse projection into the wedge. So likewise you can actually I can give you this problem that I give the wedge formula and then convert it into the Fischer projection or in the Newman projection. So lot of problems can be generated by through this inter-conversion okay?

So this is a very important concept. You have to learn how to draw the correct Fischer projection formula of the Fischer or Newman or saw horse, whichever you are comfortable with and how to draw it correctly and how to inter-convert them correctly okay? So that is the different two-dimensional representations of the three-dimensional molecule because remember, the chiral molecules are all nonplanar molecules.

They are not planar molecules. Planar molecules cannot be chiral because all in a molecules have a plane of symmetry. Planar means it has got plane of symmetry. The plane itself is the plane of symmetry. So what we are dealing with all? The chirality means three-dimensional geometry. So this is very important, that projection formula, use of projection formula in describing the stereochemistry of the molecules okay?