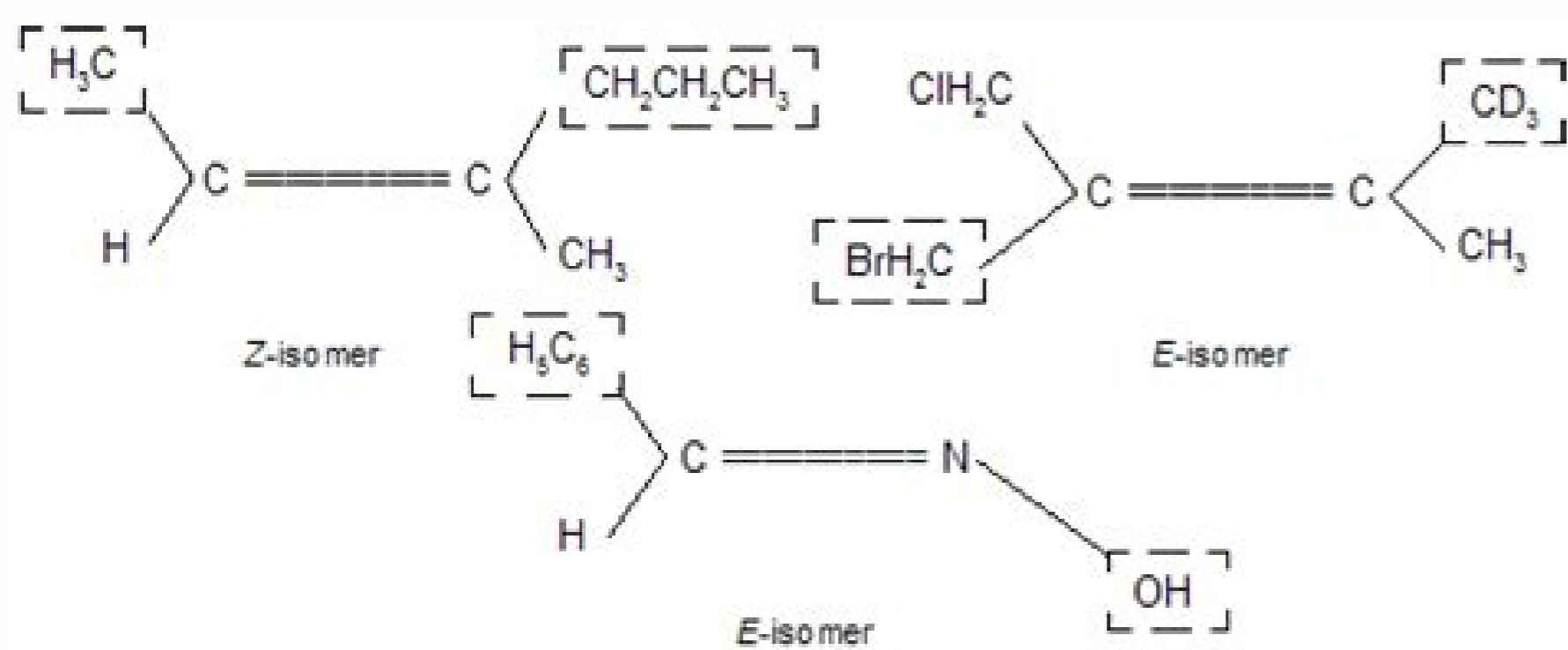
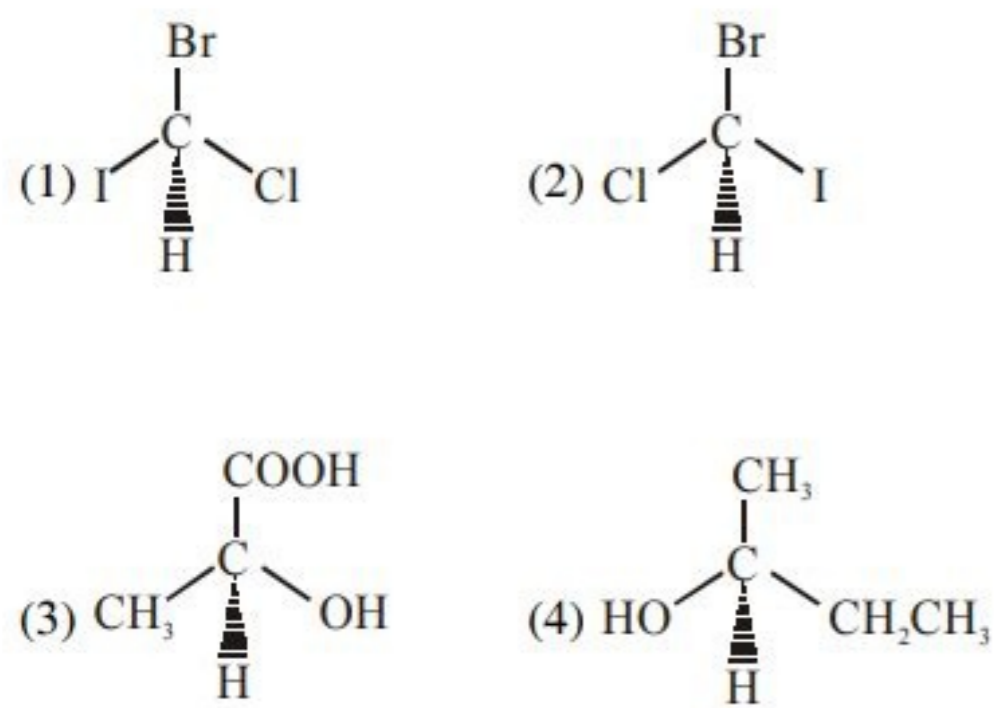
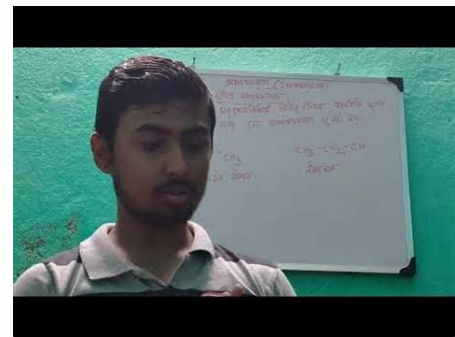


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n	Molecular formula, C _n H _{2n}	Structural formula	Number of isomers
4	C ₄ H ₈		3
5	C ₅ H ₁₀		5



Aim: What are functional groups?

Functional group isomerism and position isomerism. Functional group isomerism is not possible. Functional group isomerism definition. Functional group isomerism class 11. Functional group isomerism for ch3ch2ch2oh. Functional group isomerism example. Functional group isomerism of carboxylic acids may be.

This page explains what structural isomerism is, and looks at some of the various ways that structural isomers can arise. Isomers are molecules that have the same molecular formula, but have a different arrangement of the atoms in space. That excludes any different arrangements which are simply due to the molecule rotating as a whole, or rotating about particular bonds. For example, both of the following are the same molecule. They are not isomers. Both are butane. There are also endless other possible ways that this molecule could twist itself. There is completely free rotation around all the carbon-carbon single bonds. If you had a model of a molecule in front of you, you would have to take it to pieces and rebuild it if you wanted to make an isomer of that molecule. If you can make an apparently different molecule just by rotating single bonds, it's not different - it's still the same molecule. In structural isomerism, the atoms are arranged in a completely different order. This is easier to see with specific examples. What follows looks at some of the ways that structural isomers can arise. The names of the various forms of structural isomerism probably don't matter all that much, but you must be aware of the different possibilities when you come to draw isomers. These isomers arise because of the possibility of branching in carbon chains. For example, there are two isomers of butane, C₄H₁₀. In one of them, the carbon atoms lie in a "straight chain" whereas in the other the chain is branched. Be careful not to draw "false" isomers which are just twisted versions of the original molecule. For example, this structure is just the straight chain version of butane rotated about the central carbon-carbon bond. You could easily see this with a model. This is the example we've already used at the top of this page. Example 1: Chain isomers in Pentane. Pentane, C₅H₁₂, has three chain isomers. If you think you can find any others, they are simply twisted versions of the ones below. In position isomerism, the basic carbon skeleton remains unchanged, but important groups are moved around on that skeleton. Example 2: Positional isomers in C₅H₁₂Br. For example, there are two structural isomers with the molecular formula C₅H₁₂Br. In one of them the bromine atom is on the end of the chain, whereas in the other it's attached in the middle. If you made a model, there is no way that you could twist one molecule to turn it into the other one. You would have to break the bromine off the end and re-attach it in the middle. At the same time, you would have to move a hydrogen from the middle to the end. Another similar example occurs in alcohols such as C₄H₁₀O. These are the only two possibilities provided you keep to a four carbon chain, but there is no reason why you should do that. You can easily have a mixture of chain isomerism and position isomerism - you aren't restricted to one or the other. So two other isomers of butanol are: you can also get position isomers on benzene rings. Consider the molecular formula C₇H₇Cl. There are four different isomers you could make depending on the position of the chlorine atom. In one case it is attached to the side-group carbon atom, and then there are three other possible positions it could have around the ring - next to the (CH₂) group, next-but-one to the (CH₂) group, or opposite the (CH₂) group. In this variety of structural isomerism, the isomers contain different functional groups - that is, they belong to different families of compounds (different homologous series). Example 3: Isomers in C₃H₆O. A molecular formula C₃H₆O could be either propanal (an aldehyde) or propanone (a ketone). There are other possibilities as well for this same molecular formula - for example, you could have a carbon-carbon double bond (an alkene) and an -OH group (an alcohol) in the same molecule. Another common example is illustrated by the molecular formula C₃H₆O₂. Amongst the several structural isomers of this are propanoic acid (a carboxylic acid) and methyl ethanoate (an ester). Jim Clark (Chemguide.co.uk) Functional isomerism occurs when substances have the same molecular formula but different functional groups. This means that functional isomers belong to different homologous series. You won't meet these in GCSE Chemistry, but you do come across them at A Level. There are three functional group isomers of which you need to be aware: alcohols and ethers aldehydes and ketones carboxylic acids and esters. The functional group in alcohols is the hydroxyl group, -OH. The functional group in ethers is R₁-O-R₂. The symbols R₁ and R₂ represent the structures of the rest of the molecule; they can be the same or different if one is a hydrogen atom, the compound contains a hydroxyl group and is not an ether. R₁ and R₂ are methyl groups, -CH₃, in methoxymethane. Aldehydes and ketones both have the carbonyl group C=O. This functional group can be in different positions: in aldehydes it is attached to one or two hydrogen atoms. In ketones it is attached to two carbon atoms. These have different functional groups: carboxylic acids have the carboxyl group -COOH esters have the functional group R₁COOR₂. The symbols R₁ and R₂ represent the structures of the rest of the molecule; they can be the same or different if one is a hydrogen atom, the compound contains a carboxyl group and is not an ester. R₁ and R₂ are methyl groups, -CH₃, in methyl ethanoate. Click the following link for a Carbon and Functional Groups Student Learning Guide to accompany this tutorial. 1. Introduction In the last tutorial, we saw how carbon can covalently bond with itself and atoms of other elements to form chains, rings, and branched molecules. Carbon's versatility in forming bonds allows for molecules that have the same number and types of atoms, but which have different structures. For example, the two molecules below are both variations of the formula C₅H₁₂. That makes them isomers: molecules with the same number and types of atoms, but with different structures. Once we know a bit more chemistry, we'll come back to isomers and look at some of their biological implications. Chain Branched molecules Because the two molecules above consist solely of carbon and hydrogen, they're classified as hydrocarbons. Fossil fuels (petroleum, natural gas, and coal) are hydrocarbons. For over 200 years, fossil fuels have powered the rise of our industrialized civilization. At the same time, emissions from burning fossil fuels are disrupting our climate, a topic you can learn more about at our Greenhouse Effect and Climate Disruption tutorial. Glucose While hydrocarbons are essential fuels, they're not particularly important in living things. Rather, the molecules that compose living things are typically organized like the molecule of glucose (a common sugar) shown to the right. What you see, in this case, is a chain of carbon atoms, with many of the carbons attached to small groups of other atoms. These small groups of atoms act as a unit and are called functional groups. Let's continue using glucose as an example. If you look at carbon number 1, you can see that this carbon atom, in addition to sharing electrons with a hydrogen atom, is also double-bonded to oxygen. That carbon, with its double bond to oxygen, is a functional group, and its presence (along with other functional groups) helps to determine the chemistry of whatever molecule it's attached to. Similarly, Carbons 2 through six are bonded both to hydrogen and to an -OH. The "-OH" is another functional group. Biology students need to know seven of these groups. Start by taking a few minutes to study the table below. If you are unfamiliar with the idea of polarity and its consequences, you can jump back to our tutorials on water, polarity, and hydrogen bonding. Functional Groups Name Structure Key effect on molecules Hydroxyl Makes a molecule polar. Carbonyl Makes a molecule polar. Carboxyl Makes a molecule acidic (because it can donate H⁺ to a solution). Amino Makes a molecule basic (because it picks up an H⁺ from the solution). Sulfhydryl Two sulfhydryls can form Sulfur-Sulfur bonds (also called "disulfide bridges"), which are important in protein structure. Phosphate Important in energy transfer. Methyl Makes a molecule non-polar. Can bind to DNA, affecting gene activity (usually turning genes "off") Acetyl A component of many organic molecules. Can bind to DNA-associated proteins, enhancing gene expression. Three of the functional groups, carboxyl, amino, and phosphate can be shown in an ionized or unionized form. You should be able to recognize both forms when you see them attached to molecules. Study the table below. Functional Groups Name Non-ionized form Ionized form Carboxyl Amino Phosphate 4. More about isomers At the beginning of this tutorial, I described how molecules with the same number and types of atoms, but different arrangements of those atoms, are called isomers. There are three types of isomers to know about. Structural isomers are the kind we looked at above (and shown again below for your convenience). Chain Branched molecules Both of these molecules have the same molecular formula (C₅H₁₂), but their structural arrangement differs. The different arrangements can have the effect of giving these molecules different physical and chemical properties. The second type of isomer is a cis-trans isomer. Cis-trans isomers are the result of the fact that double bonds (two shared pairs of electrons) are geometrically fixed, and don't allow the atoms they join to rotate around the bond axis. Take a look at these two molecules, both of which have the formula C₄H₈. C₄H₈, cis configuration C₄H₈, trans configuration They are clearly isomers, with a different geometry. Note how the two methyl groups in the molecule on the left are on the same side of the double bond, which is referred to as a cis configuration. In the molecule on the right, the two methyl groups are on opposite sides of the double bond, which is referred to as a trans configuration. As with structural isomers, the different locations of the methyl groups can alter the chemical and physical properties of these molecules. You might have heard about trans fats, and how they're bad for your heart. That's correct, and you'll learn more about them in my videos and interactive tutorials about biochemistry. Click here if you want to jump ahead to that topic now. The last type of isomers are molecules that are non-superimposable mirror images of one another. That sounds abstract, but it's simple. Hold your hands out in front of you. Your hands are analogous to enantiomers: same bones, same digits, with a mirror image structure. If you made a mold that perfectly fit your right hand, your left hand wouldn't be able to fit into it. These types of isomers are called enantiomers. The two molecules below are both chemical relatives of the neurotransmitter dopamine. D-dopa (biologically inactive) L-dopa (biologically active) D-dopa L-dopa Neurotransmitters are the chemicals used to send signals from one nerve cell to the next. Dopamine works in the brains of animals (including humans) in a variety of processes, including reward and movement regulation. D-dopa and L-dopa look pretty similar, right? Let's focus on the structural formulas. Remember that in this type of structural formula, every angle vertex indicates a carbon atom. Note that the amino group in D-dopa is shown as being attached to its carbon with a dashed wedge. That dashed wedge means that the amino group is below the plane of the molecule. In L-dopa, there's a solid wedge connecting the amino group to its carbon. That solid wedge indicates that the amino group is above the plane of the molecule. Neurotransmitters (represented by "3") can only bind with receptors (E) with a complementary shape. That difference might seem trivial, but it makes these molecules as different (and as non-interchangeable) as your left and right hands. That's because neurotransmitters (represented by "3" on the right) work by binding with receptors (E) on cells. In the same way that you can't put a right-handed glove on your left hand, a receptor that can bind with L-dopa can't bind with D-dopa. The consequence is that L-dopa can serve as a medicine for people with Parkinson's disease, a condition where the brain produces insufficient amounts of dopamine. D-dopa has no pharmacological use. 5. Another Quiz: Functional groups and isomers That's about all you need to know about carbon and functional groups to succeed in an AP Bio or a first-year, introductory biology course. When we study proteins (as well as other key biological molecules) in the next module of our course, you'll see that it will be useful to be able to identify functional groups and to hold in mind which ones are polar, non-polar, acidic, basic, and so on. In the quiz that follows, just to keep you on your toes, some of the functional groups shown below are in their ionized form, but others are not. Enjoy! 6. What now? Link to

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