

Chemistry 400 – Senior Seminar

Tutorial #3 – Drawing Chemical Structures with ISIS/Draw

Assignment:

- Draw the structure outlined in this tutorial using ISIS/Draw
- Draw your assigned structure (below) using ISIS/Draw. These structures may be looked up in the Merck Index (available in the reference section of the Library).

Bill C. – paramethasone

Amanda – picromycin

Bill M. – echitamine










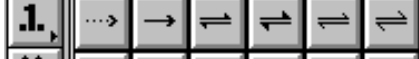
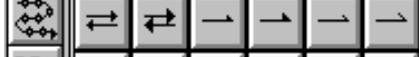




Jeremy – calcimycin

Lora – bromocresol green

Note: This tutorial *requires* the ISIS/Draw Software, which has been installed on the computers in Science 117. It may also be downloaded for free from the MDL Web Site (www.mdli.com).

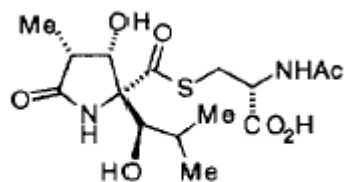
The ISIS/Draw Program

ISIS/Draw has a wide range of drawing tools specifically designed for drawing chemical structures (*see below*) and most are self-explanatory. Note that any button with a small arrow will expand to a menu of buttons if you push and hold the button for about 1 second.

Lasso Select / Select / Molecule Select Tool	
2D Rotate / 3D Rotate Tool	
Eraser Tool	
Atom Tool	
Single / Double / Triple Bond Tool	
Up / Down / Either Wedge / Up / Down Bond Tool	
Chain / Multi-Bond Tool	
Plus Tool	
Arrow Tool	
Atom-Atom Map Tool	
Sequence / Sequence Shape Tool	
Bracket Tool	
Text Tool	
Line / Continuous Line / Circular / Elliptical Arc Tool	
Rectangle / Rounded Rectangle / Polygon / Ellipse Tool	

Drawing Molecules

As a first example, we will draw the molecule shown on the right, taken from a paper on the total synthesis of α -alkyl- β -hydroxyproline derivatives. At the end of this section, we will have reproduced this structure.



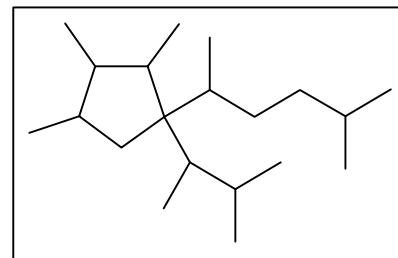
3, Lactacystin

Drawing the Skeleton Structure

- The structure is built on a five-membered heterocyclic ring, so we will start by using the template menu (shown below).



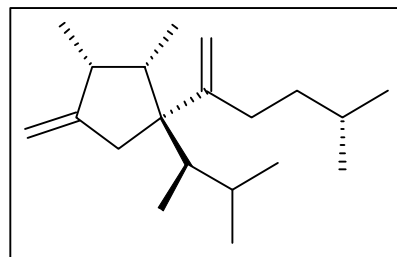
- Click on the cyclopentane template (fifth from left).
- In the drawing window, click *and drag* from right to left. (Just clicking or dragging from left to right will draw the ring in the incorrect orientation for this drawing.)
- Select the **Single Bond** tool. Click (but don't drag) on the middle-left, top-left, and top-right carbons to *sprout* the necessary bonds. Notice how ISIS/Draw sprouts a bond at an appropriate angle.
- Try *sprouting* two bonds off the middle-right carbon of the cyclopentane ring. Notice how the default sprouts generated are not appropriate for this drawing.
- Select the **Eraser** tool. Move the tool over the bonds just generated until the entire bond is highlighted (gray rectangle is drawn around it).
- Re-select the **Single Bond** tool. Click *and drag* on the middle-right carbon of the cyclopentane ring until a bond is drawn at the correct angle. Repeat to draw the second bond. Notice how the length of the bond is pre-determined (this can be changed from the **Options/Settings** menu).
- Use the **Single Bond** tool to draw the rest of the skeleton.
- At this point your structure should look like the structure on the right.



Drawing Double Bonds and Wedges

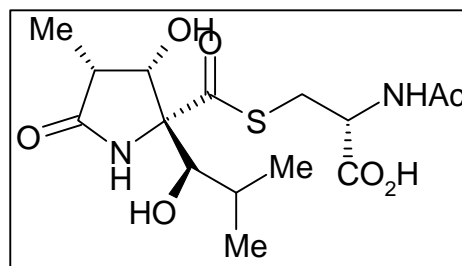
- Select the **Double Bond** tool (click and hold the **Single Bond** tool).
- Change the two bonds in the structure to double bonds by moving the **Double Bond** tool over the bond until it is highlighted and then clicking.
- Try clicking a double bond one more time with the **Double Bond** tool. Notice how ISIS/Draw changes the positioning of the double bond. Continue clicking until the positioning returns to the original configuration.
- Select the **Up Wedge** tool.
- Click on the *two* bonds that require an up wedge.
- Try clicking on a wedge bond one more time with the **Up Wedge** tool. Notice how ISIS/Draw changes the orientation of the wedge. Click one more time with the **Up Wedge** tool to return to the original configuration.

- Select the **Down Wedge** tool (click and hold on the Up Wedge tool).
- Click on the *four* bonds that require a down wedge.
- At this point your structure should look like the structure on the right.



Drawing Heteroatoms and Groups

- Select the **Atom** tool. Move the tool over the leftmost atom until a rectangle is drawn around the *atom* (not the bond!) and click.
- Type **O** and *Enter* into the box to change the atom to an oxygen.
- Do the same for the three remaining oxygen atoms (including the OH groups).
- To add the hydrogen to the OH groups, select the **Select** tool. Double click on one of the OH oxygen atoms. Under Hydrogens select Auto Position from the drop-down menu. Repeat for the other OH group.
- Select the **Atom** tool and change the middle-bottom atom of the cyclopentane ring to nitrogen. Repeat the above steps to add the hydrogen.
- Add the remaining atoms and groups (S, Me, CO₂H, and NHAc) using the **Atom** tool. Notice how ISIS/Draw knows to subscript the 2!
- At this point your structure should look like the structure on the right.



Polishing It Up

The atom labels are a bit too large for the scale of the drawing, but this is easily changed.

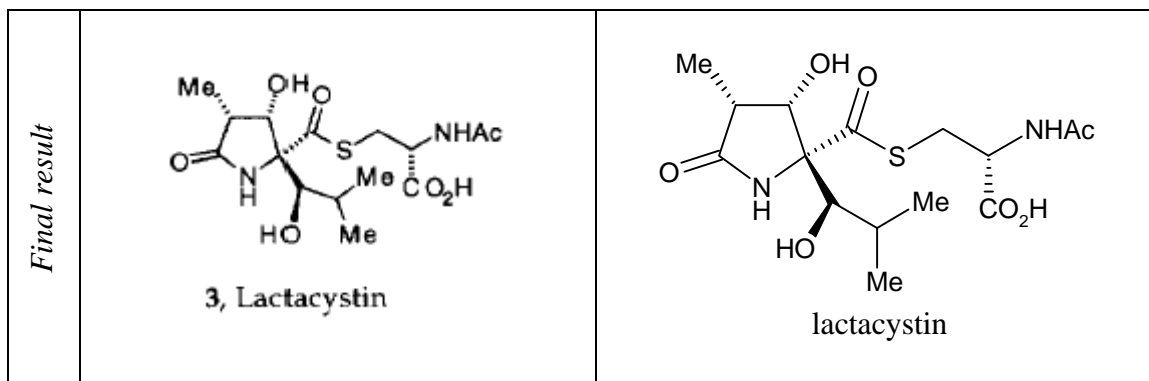
- Select **Edit/Select All** from the menu bar. Select **Text/Font** from the menu bar.
- Change the font size from 12 to 10. Click OK.

There is also a small collision between the hydroxy and carbonyl group on the top.

- Select the **Select** tool. Click on the oxygen atom of the carbonyl group.
- Drag with the mouse or use the right cursor key on the keyboard to nudge the oxygen atom out of the way.

A label would be nice...

- Select the **Text** tool. Click under the structure and type **lactacystin**.
- Select the **Select** tool. Double-click the text and change the font to Time New Roman.

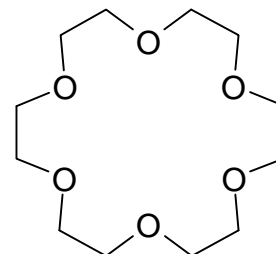


Other Useful Features

ISIS/Draw has many other useful features you may wish (or need) to explore. There is not time or space to cover all these options, but a few highlights are outlined below.

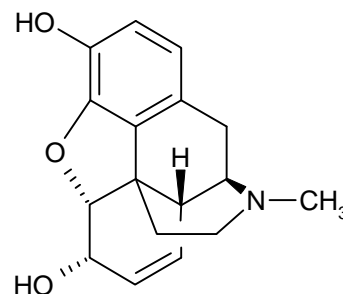
Templates

A large library of over 250 pre-drawn structures and templates is available from the **Templates** menu. Simply click the **Templates** menu and select the desired set of structures (*I selected crown ethers*). A window opens showing a number of structures or fragments. Selecting one of these creates a kind of “rubber stamp” tool – every time you click, the selected structure or fragment is generated. I selected a molecule known as 18-crown-6 (shown on right). Check it out!



Crossed bonds

Many complex organic and inorganic structures contain *crossed bonds*, points where one bond crosses in front of another (see the structure of morphine on the right). If you double-click a bond using the **Select** tool, then select crossed bond check box under the bond type, ISIS/Draw will correctly draw space around the bond in front to give perspective.



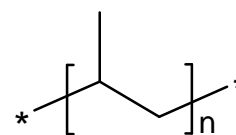
Calculating Molecular Properties

If a structure has been drawn using standard atom and group labels, selecting **Chemistry/Calculate MolValues/Calculate** will calculate molecular weight, formula, and composition. The results for the morphine structure are shown on the right.

Molecular Weight =285.35 Exact Mass =285 Molecular Formula =C17H19NO3 Molecular Composition =C 71.56% H 6.71% N 4.91% O 16.82%
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Polymers

ISIS/Draw has enough “chemical intelligence” to understand various types of polymers. Using the **Bracket** tool, I have drawn the structure of polyethylene. Options exist for drawing polymers, monomers, copolymers, block copolymers, crosslinks, etc. The **Sequence** tool can also be used to draw biological polymers including DNA, RNA, and peptides.



Copying Into Microsoft Word

A beautiful drawing is of limited use unless you can place it within your document. Luckily, it is quite easy to transfer your drawings into Microsoft Word. Simply select all or part of your drawing, select **Edit/Copy** from the menu bar, switch to Microsoft Word and select **Edit/Paste**. By default, Word will make the drawing “float” over your text, wrapping text around it as you move or type. This tends to be frustrating and the drawing rarely stays where you want it, so I would suggest the following.

In Word, select **Format/Object...** from the menu bar. Click the **Layout** tab and *unselect* the **Float Over Text** option. Now your picture will behave like a big chunk of text. I would recommend using a table to position your figure or figures.

Editing an Existing Drawing from Microsoft Word

If you later decide to change one of your ISIS/Draw-ings, this is also relatively straightforward. Simply double click on the drawing within Word. ISIS/Draw should open with your drawing in the window. Make your modifications, select **File/Exit & Return to Microsoft Word**, and click **Yes** when it asks if you wish to update Microsoft Word.