CMB311
Fall 2017
Lecture 3 Notes

In this lecture we briefly reviewed some relevant aspects of organic chemistry that are important for understanding biochemistry, then discussed acids and bases, which are also important for understanding biochemistry. Hopefully, some of this sounded familiar.

I. **Review of Organic Chemistry.** Remember that biochemistry can be thought of as a sub-discipline of organic chemistry, in that biomolecules are organic molecules.

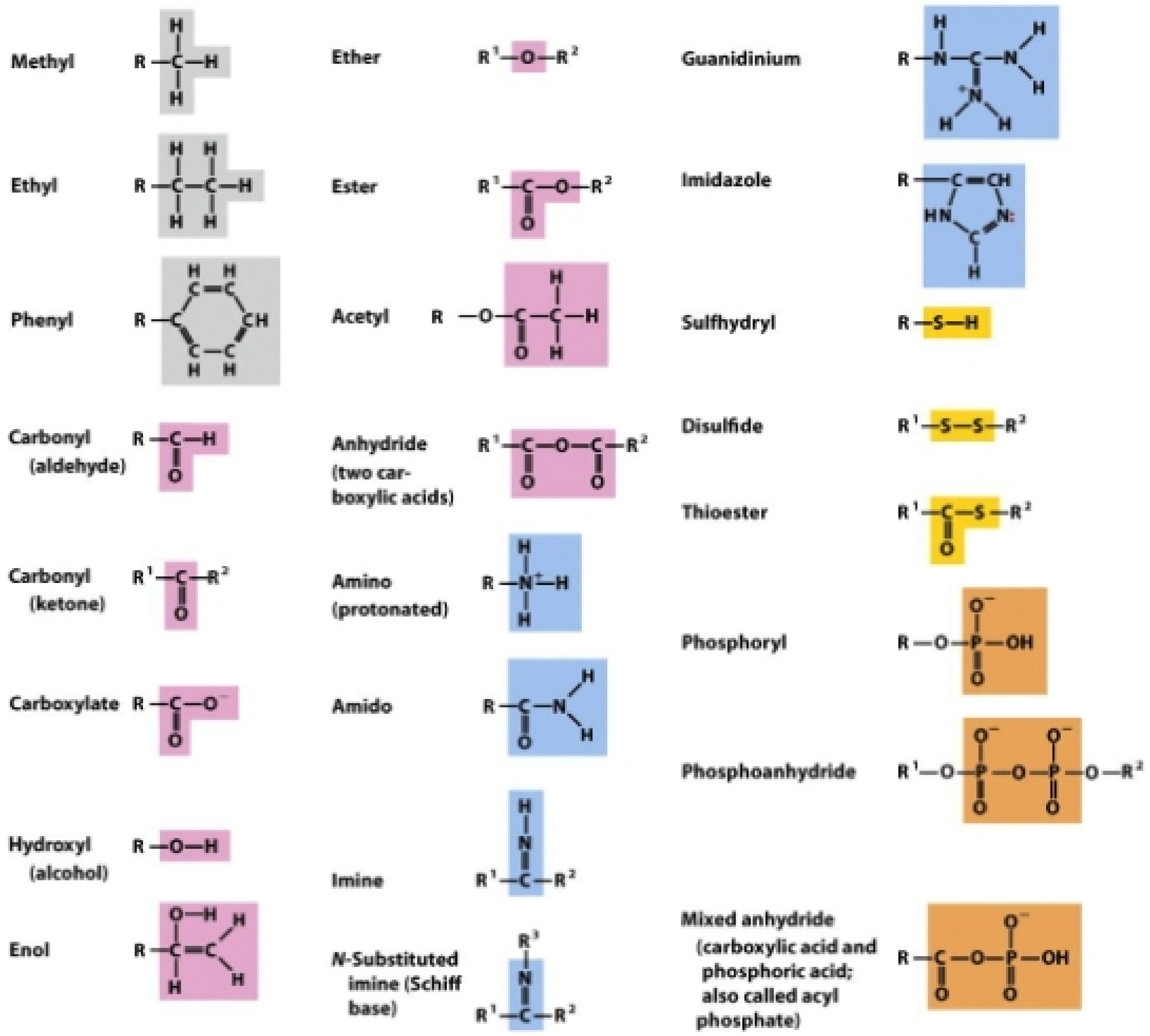
As you no doubt already know, carbon (C) is unique in its capacity to form long-chain molecules. Carbon atoms are also capable of forming four bonds, which means they can make branch-chained molecules as well. Further, they not only bond to other carbon atoms but to other elements, especially nitrogen (N), oxygen (O) and of course hydrogen (H).

There are several different ways to draw organic molecules, some of which are kinds of short cuts. This is handy, since biomolecules often have quite complex chemical structures. The most useful drawings just ignore the hydrogens, as if they're understood to be there, because everyone presumably knows the stoichiometry of carbon. Sometimes the hydrogens are drawn, because they are useful if you want to indicate hydrogen bonds, but often the covalent bonds between hydrogen and other elements are not drawn. Here are several ways to represent organic molecules:

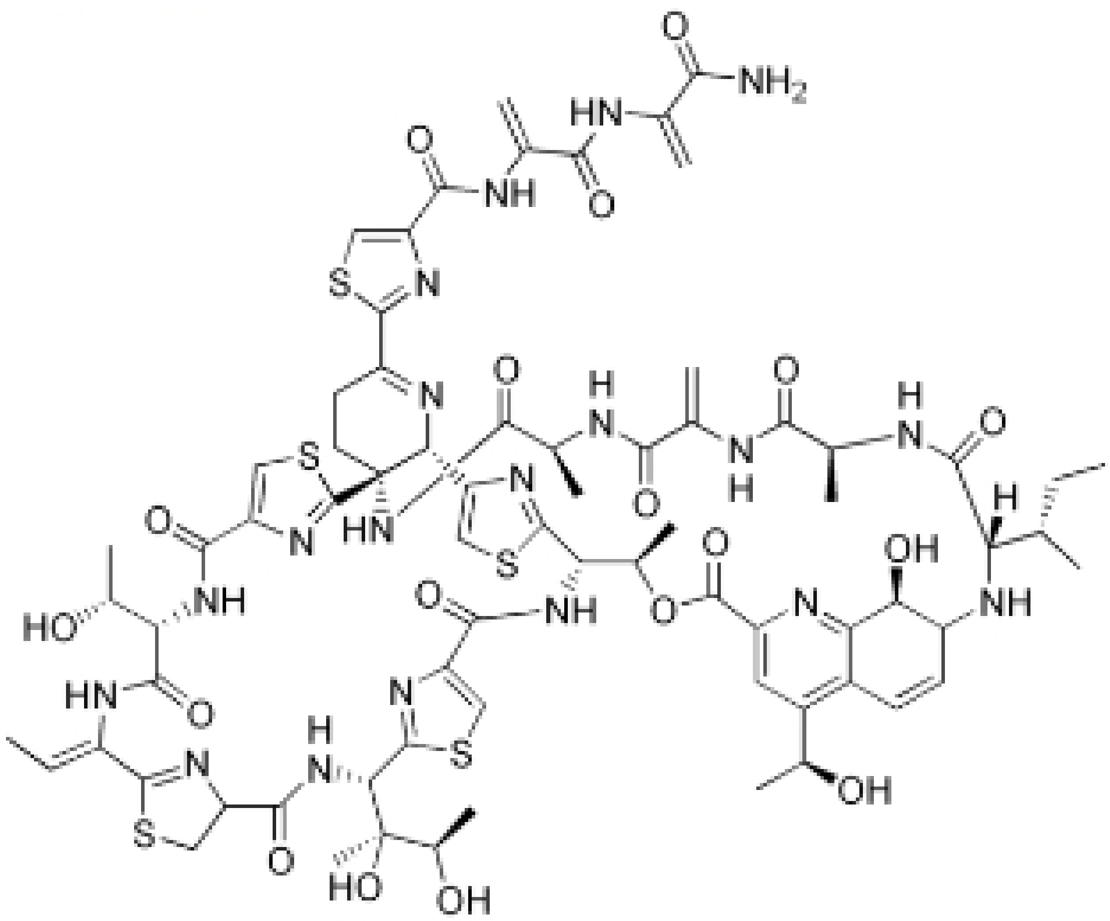
a) Molecular formula gives the chemical composition, but otherwise pretty useless.
b) Structural formula indicates the interatomic bonds.
c) Ball-and-stick model gives a three-dimensional representation including bond angles.
d) Perspective drawing provides the same information as the ball-and-stick, just not as pretty.
e) Space filling model gives an accurate representation of the three-dimensional structure including van der Waals radii. Bond angles not quite as easy to see as with the ball-and-stick and persepctive drawings.
f) Condensed structural formula is like the molecular formula, but is organized into functional groups and therefore more informative.

Speaking of which, what exactly are 'functional groups'? These are groups of atoms that give a molecule its properties. They are often centers of chemical reactivity. The reason for focusing on functional groups is that they not only reflect the structural organization of a molecule, but are chemically meaningful, in that a given element's behavior will depend on what it's bonded to. Thus an oxygen atom in a hydroxyl group behaves differently from an oxygen in a carboxyl group. Familiarity with functional groups is also important because they are involved in the kinds of interactions in biomolecules, including hydrogen bonding, ionic bonding, and hydrophobic interactions.

In the powerpoint slides, I've included a list of organic functional groups found in biomolecules. It's worth reviewing these as it provides a kind of lexicon for discussing the behavior of biomolecules. Based on our discussion in Lecture 2 about hydrogen bonding and the hydrophobic effect, you should be able to predict the properties of each of the functional groups. Are they likely to engage in hydrogen bonding? Are they hydrophobic? Are they hydrophilic? We finished with some examples of hydrogen bonding interactions that are important in biochemistry. Before we begin describing the molecules that comprise proteins and nucleic acids, we need to make sure that everyone is on the same page, so that no one gets lost in the jargon. Hopefully, this discussion of organic chemistry was all review for everyone.



You should get to the point where you feel at ease in identifying the functional groups of any organic molecule you are given. Some biomolecules are extremely complex and contain numerous functional groups. Knowing their names will make scary looking molecules like the one below look less intimidating...



I. Acids, Bases and pH

Next we discussed acids and bases and pH, because biological molecules are highly sensitive to pH, and because ionizable groups are important for the behavior of biomolecules.

Some definitions:

Acid: a molecule that behaves as a proton donor

Base: a molecule that behaves as a proton acceptor

A strong acid (or strong base) is one that completely dissociates. Weak acids and bases dissociate less readily. Most biologically relevant acids and bases are weak. Acid strength can be assigned a numerical value based on the dissociation constant, K_a as shown below:

$$HA\ (acid) \rightleftharpoons H^+ + A^-$$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

For water:

$$K_a = \frac{[H^+][OH^-]}{[H_2O]}$$

$$K_a \times 55.5 = [H^+][OH^-] = K_W$$