

Lecture 19B • 05/31/12

Amino acids

[d/l – relative configuration of the amino group when you write these amino acids in a particular form] The standard way is the have the acid portion of the compound up top, just like we put the carbonyl of a carbohydrate up at top, and then we put the R group, if there is one, down at the bottom. Then, it's the orientation of that amino group that determines whether it is an l amino acid. [amino acids with alkyl groups]

[essential amino acids] Protein contains amino acids. When we consume protein, our body breaks down these peptide chains to give us a source of amino acids. Some of those amino acids, if they happen to be deficient in food sources, we're able to synthesize our own selves as creatures; some of them, though, we can't, and we have to have them [through] outside sources, or we can't easily synthesize them. Those amino acids that are not easily self-synthesizable, those are referred to as the essential amino acids. [20 most-common amino acids, now other additional ones – sulfur and selenium-containing amino acids in extremophiles in sulfur springs]

[classes of amino acids – alkyl, alanine; alcohol, serine; sulfur, cysteine; second carboxylic acid, aspartic acid; amide, asparagine; second amino group, lysine; benzene, phenylalanine; heterocycles – proline] Proline is unusual because it is an alpha amino acid, but the amino itself is a secondary group.

Isoelectric point

The pH at which an amino acid exhibits the greatest percentage of its neutral form – neutral meaning non-charged [zwitterionic]. For some amino acids, it's easy to figure out what this point is. Using alanine as our simple case, we have two pKa values. [pKa1 = 2.34, pKa2 = 9.69] If we know what the dissociation constant is for the acid is, and the effect dissociation constant in reverse for the base, you're going to have a point in between the two where you're maximizing how much of this neutral form you form. In other words, if I took this amino acid and put it just in a strong acid, a concentrated solution of a strong acid, maybe has pH 0, pH 0 means definitely the amino group is going to be protonated and the carboxylic acid group is also going to be protonated. Once you get to 2.34, what proportion of the cationic versus zwitterionic forms of this compound will we have in solution? At pH 2.34, what's going to exist in solution? The acid form? What [is] the significance of the pH being equal to the pKa? It's the half-equivalence point. That means if the pH is 2.34, we're going to have 50% of the form that I've shown you here and 50% of the cationic form. Similarly, at pH 9.69, we would say that the proportion of the neutral form is equal, roughly, to the proportion of the deprotonated, the anionic form. [graph with acid/neutral/base forms] There were these crossover points at half mole fraction of 50% that we had the crossover between the curves. That is where the pH = pKa1 and pKa2. Notice that the neutral form appears to hit its maximum right in between. For those amino acids that only have one amino group, one acid group, we have the pI, which is equal to the average of the two pKa values. Average, where does that come from? It would be equivalent to the square root of the product of the equilibrium constants. If we wanted to treat these things as equilibrium constants, those multiply. When you take the log of a product, you end up adding the logs. This is an additive log statement that has to do with the fact that you have two equilibria going on at the same time; to get an overall equilibrium, you would multiply those things together. This is for amino acids that do not have an acidic or basic side chain; it doesn't have an ionizable side chain.

What if we did have one of these groups that had multiple acids or bases on it – for example, lysine. If you only had one amino group and one acid, then you need an equal amount of both of those things to end making [neutralized]. Both of these amino groups, in the case of lysine, are bases, so in between those two functional groups, then you're going to have the same amount of base form that would still balance out against the acid form. If you have a functional group like this with two bases, the pI is not the average of the acid and the base, but of the two bases' pKas. If you have aspartic acid, where you have two groups on there, then the pI is the average of the two acids, because if you're at that point, you're then going to automatically balance out with the amino end. pKa 1 is still going to be associated with the carboxylic acid; pKa 2 in this case – the 2 refers to the alpha-amino group; pKa 3 for the side chain. The pI would be the average of those two [pKa 2 + pKa 3] values.

essential amino acids – those amino acids that the body is not able to produce (or produce easily) and must therefore be supplied by food. 20 "most-common" amino acids

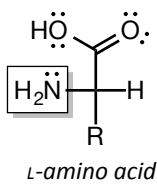
Classes of amino acids – types of side chains

- | | | | |
|--------------|---------------------------|----------------------------|-------------------------|
| 1) R = alkyl | 2) R = alcohol-containing | 3) R = [sulfur]-containing | 4) R = carboxylic acids |
| 5) R = amide | 6) R = amino | 7) R = [aromatic] | 8) R = heterocycle |

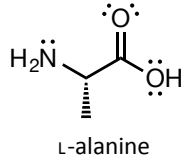
Isoelectric point → pH at which an amino [acid] exhibits the greatest percentage of its neutral form.

Structures

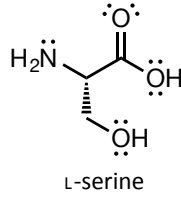
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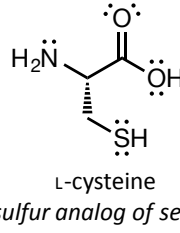
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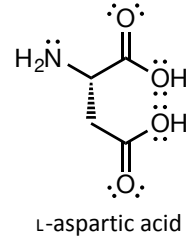
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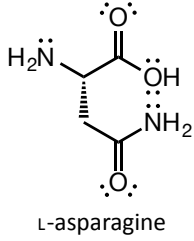
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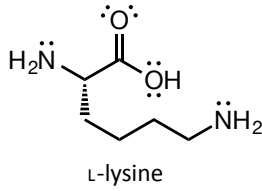
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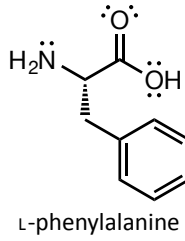
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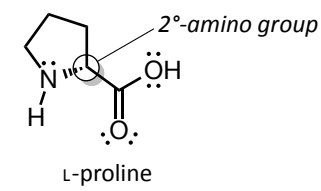
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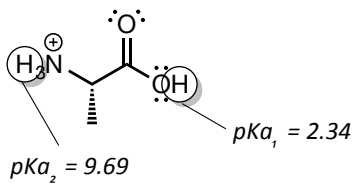
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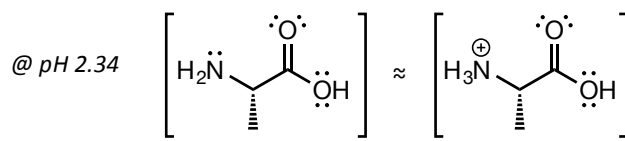
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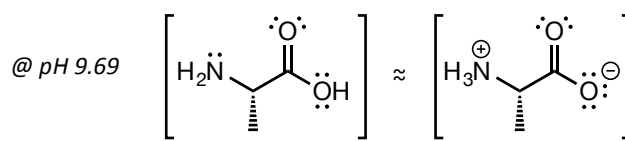
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