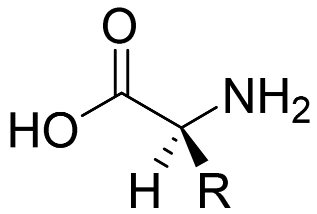
TA2 - Amino Acids

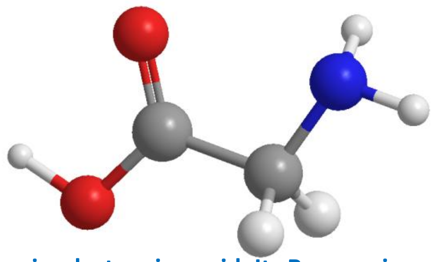
Amino acids are often referred to as the 'building blocks of life'. This is because they combine in different sequences to form proteins, which are fundamental to all living organisms. There are 20 amino acids commonly found in nature, 9 of these are called '**essential'** because they are important for human health, but cannot be made in the body. We must obtain them through our diet.

THE STRUCTURE OF AMINO ACIDS

All amino acids have the same backbone containing carbon, oxygen, hydrogen, and nitrogen. The **R-group** you can see in the general formula represents the different **side chains** attached to each amino acid. This is the part which differentiates each of the 20 amino acids. These different R-groups determine the **chemical personality** of an amino acid; they each have a **distinct shape, size and charge distribution and can be large and bulky or small, and polar or non-polar**. The R-group is important because the properties of amino acids dictate how they interact with each other.



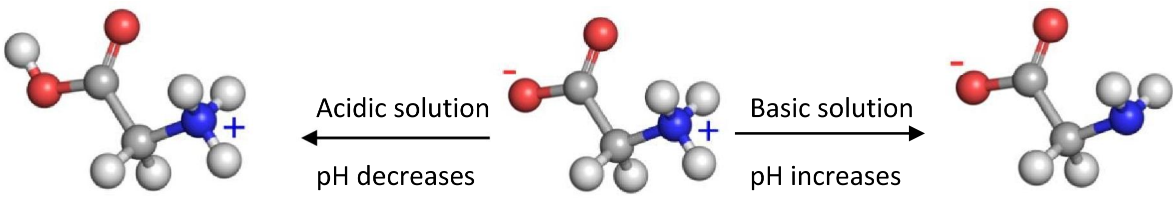
The general structure of an amino acid. Note that it has an amine group, a carboxylic acid group, and a central carbon with an H and an R-group.



Glycine is the simplest amino acid. Its R-group is another hydrogen atom. As we will see, R-groups can vary considerably, and affects the nature of the entire molecule. They can be aliphatic, aromatic, basic, or contain sulfur.

ZWITTERIONS

As you can see from the general formula above, amino acids have a basic amine group, and an acidic carboxy group, hence the name amino acid! This is really important, because when these molecules are in either bulk solid or solution, the acid group can lose a H^+ and the amine group can gain a proton. An amino acid which has done this is called a **zwitterion**, and has two charged groups, such as the molecule in the middle.



In acidic solution, there's a high concentration of H^+ ions. This keeps the carboxylic acid group protonated, and protonates the amine group.

You may expect that in neutral solution, the amino acid should be neutral too, but that's not the case. The pH is actually high enough to deprotonate the acid, and yet low enough to protonate the amine. This means that the acid loses a proton, and the amine group gains one, producing a zwitterion.

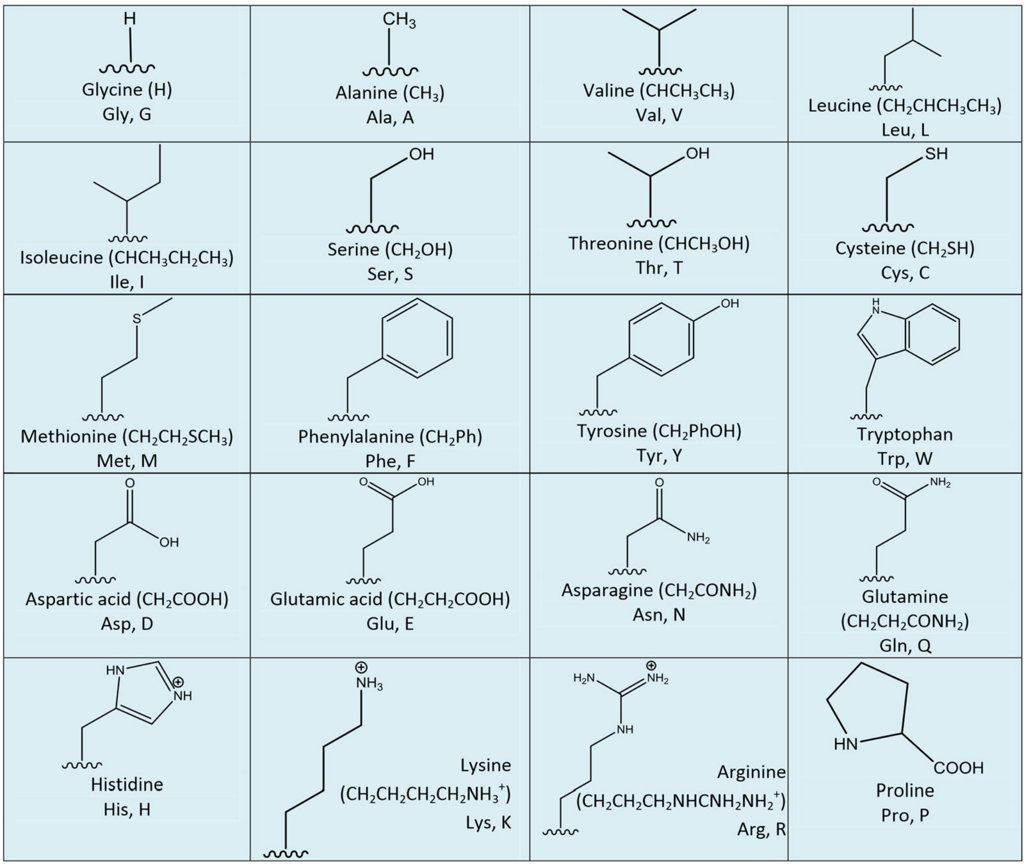
In basic solution, there's a low concentration of H^+ ions, and a high concentration of HO^- ions. This deprotonates the carboxylic acid group protonated, and stops the amine group being protonated.

Produced by Lucy Jakubecz at Newcastle University as part of an MChem project.
Edited by Adam Stubbs at Newcastle University as part of a summer outreach project.

This is important to remember: amino acids exist as zwitterions when in **neutral solution**, with each side being charged. Because there is no overall charge on the molecule, we call this the **isoelectric point**. If the solution's pH is acidic, or basic, then this will change the structure of the amino acid.

AMINO ACID SIDE CHAINS

The side chains determine the chemical personality of the amino acid, and affect how the amino acids interact and combine. You don't need to remember the different amino acid names or side chains! You just need to be aware that each is different, and this gives them each different properties. For example, alanine, valine, leucine and isoleucine all have hydrocarbon chains, this makes them hydrophobic. Similarly, serine and threonine have hydroxy groups, so they are hydrophilic. This becomes very important when looking at the structures of proteins, and protein folding, because the amino acids in a protein can interact with each other. For example, the basic amino acids, such as lysine, can form ionic bonds with the acidic ones, such as aspartic acid. This can 'fold' the protein into a particular structure, which affects the protein's shape and function.



HOW DOES AN ORGANISM KNOW HOW TO PRODUCE SPECIFIC AMINO ACIDS?

As the amino acids build up to create proteins, the specific amino acids become very important. Especially for proteins such as enzymes, where the specific amino acids involved determine how the enzyme can bind to certain substrates.

Each amino acid is coded for by DNA bases. Three DNA bases combine to code for each amino acid, this is known as the **triplet code**, and each triplet code is known as a **codon**. For example, codon AGC codes for the amino acid serine. When proteins are built, the specific triplet codes are read off, so that the correct amino acid is synthesised.

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