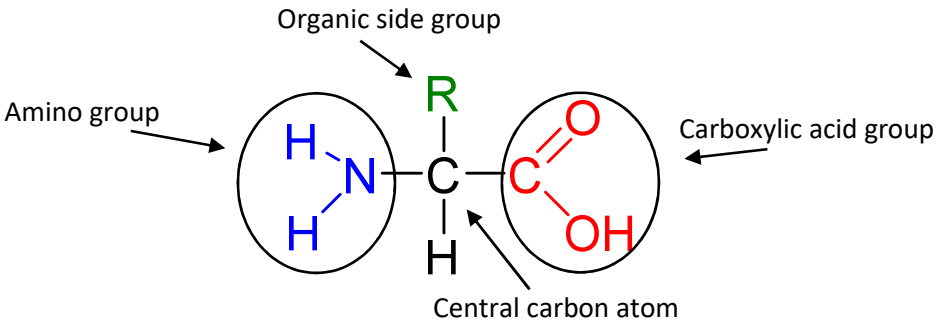
TC7 – Amino Acid Behaviour

STRUCTURE



Amino acids have an amino group, which is basic, and a carboxyl group, which is acidic. This means that amino acids have both acidic and basic properties. This is called amphoterism.

The carboxyl group can donate protons (acidic):

$$RCOOH \rightleftharpoons RCOO^- + H^+$$

The amino group can accept protons (basic):

$$RNH_2 + H^+ \rightleftharpoons RNH_3^+$$

ZWITTERIONS

When amino acids are in solution, they can have both a positive and a negative charge. These molecules which have both their carboxylic acid and amino groups charged are called zwitterions. The pH at which this point occurs is called the isoelectric point (pI), this is the point at which the average overall charge on the molecule is zero. Each amino acid has its own isoelectric point. It is important to note that this point is for the nearly every amino acid in a solution to have both a positive and negative charge. At pH values close to the isoelectric point, many of the amino acids will still exist as zwitterions.

Amino Acid	Isoelectric Point, pI
Aspartic Acid	2.77
Glutamic Acid	3.22
Cysteine	5.07
Asparagine	5.41
Phenylalanine	5.48
Threonine	5.60
Glutamine	5.65
Tyrosine	5.66
Serine	5.68
Methionine	5.74
Tryptophan	5.89
Valine	5.96
Glycine	5.97
Leucine	5.98
Alanine	6.00
Isoleucine	6.02
Proline	6.30
Histidine	7.59
Lysine	9.74
Arginine	10.76

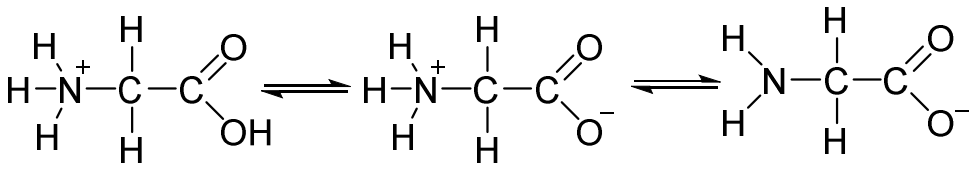
Table of amino acids and their respective isoelectric points around room temperature. Actual values change with temperature.

Produced by Alex Greer at Newcastle University as part of a Nuffield Research Placement.
Edited by Adam Stubbs at Newcastle University as part of a summer outreach project.

HOW DO AMINO ACIDS CHANGE IN ACIDIC AND IN BASIC CONDITIONS?

In conditions that are more acidic than the isoelectric point of an amino acid, then the amino group will be protonated by the acid – adding H^+. The carboxylic acid group will stay protonated, so the amino acid will be positive.

In conditions that are more basic than the isoelectric point of an amino acid, then the carboxylic acid group is deprotonated, as the base removes H^+. The amino group will remain unchanged, so the amino acid will be negative.



Acidic: pH < pI

Neutral: pH = pI
Zwitterionic

Basic: pH > pI

ADDING BASE TO POSITIVELY CHARGED AMINO ACIDS

A positively charged amino acid has two acidic hydrogens. One from the R-NH_3^+, and another one from the R-COOH. If you slowly add a base, then a proton will be removed from the more acidic of the two group, R-COOH, forming a zwitterion. When more base is gradually added, then the R-NH_3^+ group will be deprotonated to form a negatively charged amino acid.

ADDING ACID TO NEGATIVELY CHARGED AMINO ACIDS

A negatively charged amino acid has two basic groups. One from the R-NH_2, and another one from the R-COO^-. If you slowly add acid, then the more basic of the two groups, R-NH_2, will be protonated, forming a zwitterion. When more acid is gradually added, then the R-COO^- group will be protonated to form a positively charged amino acid.

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