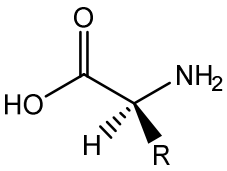
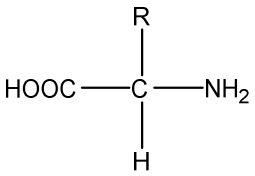
Name:
Date:

QC1 - Amino Acid Chemistry

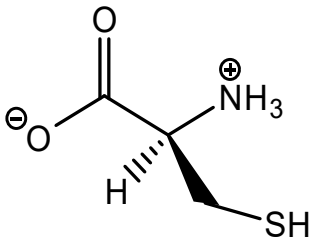
1. Draw out the general structure of an amino acid.





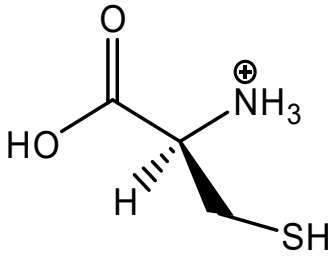
Either structure is acceptable, but the structure on the left is preferred as it shows the stereochemistry of the amino acid.

2. The side chain of cysteine is CH_2SH. Using this, draw the structure of cysteine as it would appear in neutral solution.



3. Explain why cysteine exists in this form.
In neutral solution, the carboxylic acid group can be deprotonated, and the amine group can be protonated. So, you form a **zwitterion**, which is an amino acid that has **overall neutral charge, but has two ionic groups.**

4. Similarly, draw the structure of cysteine as it would appear in acidic solution.



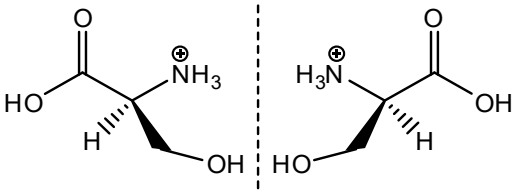
5. Define the term 'isoelectric point'.
The **pH** at which there is **no overall charge** on the molecule, because the negative charge on the carboxylate group is cancelled by the positive charge on the ammonium group.

Produced by Adam Stubbs at Newcastle University as part of a summer outreach project.

6. Most amino acids have a property known as chirality. Define chirality and explain why it occurs. In the process, define the term enantiomer.
   Chirality means that an object **cannot be superimposed onto its mirror image**. It occurs when a **central atom such as carbon has four different groups** attached to it. A chiral atom has **two possible isomers, which are called enantiomers**. **Enantiomers are mirror images** of each other which cannot be superimposed onto each other.

7. How do the chemical and physical properties of enantiomers differ?
   Enantiomers have **identical chemical properties**, **except** when reacting with other **chiral species**, such as chiral molecules or enzymes. Enantiomers have **identical physical properties**, **except** for their effect on the plane of **plane-polarised light**. Each enantiomer will rotate light in an opposite direction, and this is indicated by the prefix D/L.

8. Draw the enantiomers of serine, which has a CH_2OH side chain.



9. How can we determine which enantiomer is D-, and which one is L-?
   We have to perform a **polarimetry** experiment. It **cannot** be worked out **theoretically**.

10. Describe the effect that amino acid side chains can have on the overall structure and function of a protein.
    Amino acids can have many **different side chains which determine the chemical personality** of the amino acid. Importantly, they affect how the amino acids can **interact** with each other. Proteins are formed from long polymeric chains of amino acids. These **polypeptide chains can interact and 'fold' in 3D** to form a variety of shapes and structures. For example, some amino acids have basic side chains, which can form ionic bonds with the acidic side chains of other amino acids. These ionic bonds will force the amino polypeptide chain to adopt a particular shape. This means that the amino acids in a protein affect its overall structure greatly. The **structure of a protein is fundamentally linked to its function**, for example enzymes have a very specific active site which only works correctly if the protein has the right structure.