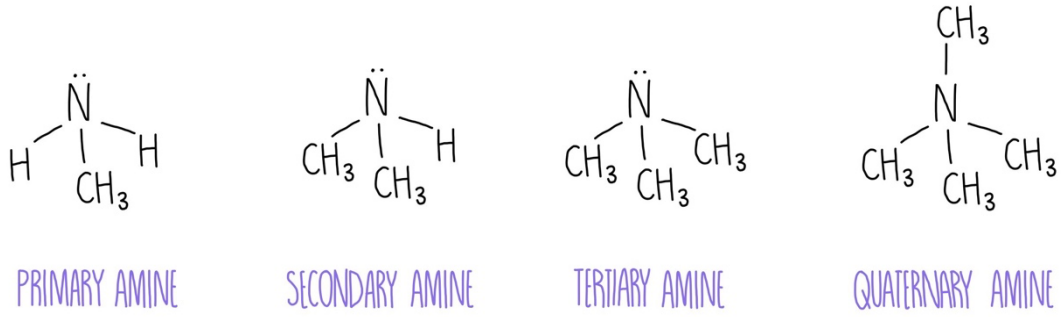
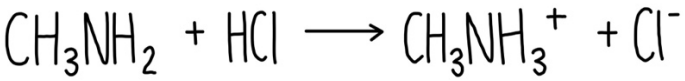
Amines, amides, and amino acids

Properties of amines

- Amines are **ammonia** (NH_3) with one or more of the hydrogens replaced with an **alkyl group.**
- **Primary amines** are formed when **one** alkyl group is bound to nitrogen, **secondary** if you have **two** groups and **tertiary** when there are **three** groups.
- **Quaternary** amines are formed when the nitrogen is bound to **four** alkyl groups (using its lone pair).

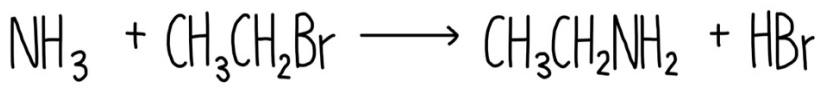


- Ammonia and amides act as **bases** — they use their lone pair to bind hydrogen ions.
- Since both bonding electrons come from the amide/ammonia, a dative covalent bond is formed.

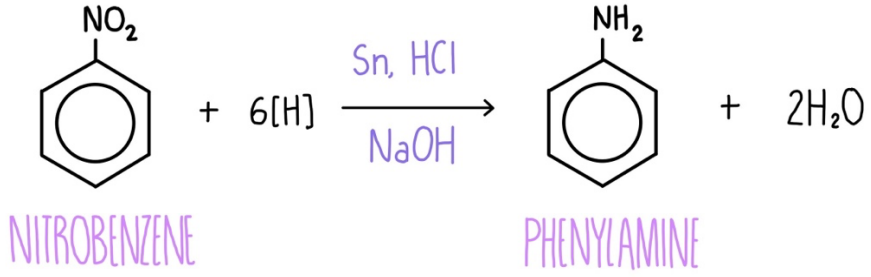


Forming amines

- Amines are made by reacting **ammonia** with a **haloalkane**.
- E.g., ammonia will react with bromoethane to produce ethylamine.
- Ethylamine can **further react** to form diethylamine and trimethylamine. Ammonium bromide is formed as the second product.
- The amines are separated by **fractional distillation**.

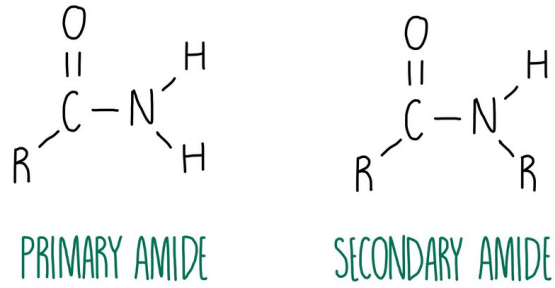


- **Aromatic amines** (amines which contain a benzene ring) are made by **reducing nitrobenzene**.
- Nitrobenzene is heated under **reflux** in the presence of **concentrated hydrochloric acid**, a **tin catalyst** and **sodium hydroxide**.
- Phenylamine and water are formed as the products of the reaction.

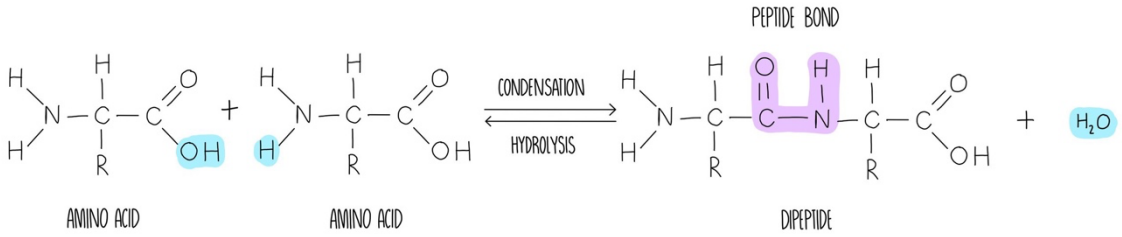


Amides

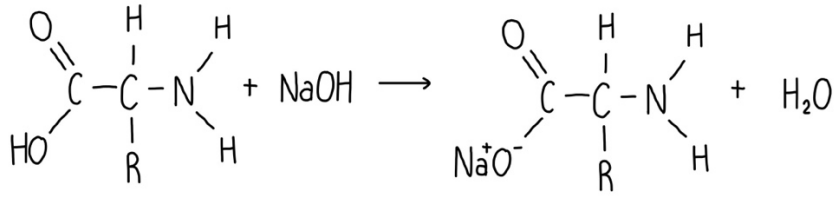
- Amides are compounds that contain a **carbonyl group (C=O)** next to an **amine group (-NH_2)**.
- In primary amides, the nitrogen is bound to only one carbon atom. In secondary amides, the nitrogen is bound to 2 carbons.



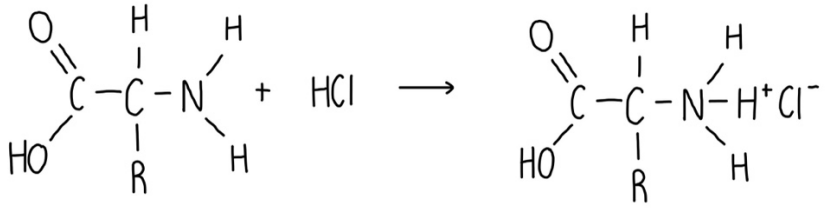
- **Proteins** contain amide bonds (also known as peptide bonds) which are formed when the **carboxylic acid** group on one amino acid reacts with the **amine group** on another amino acid.



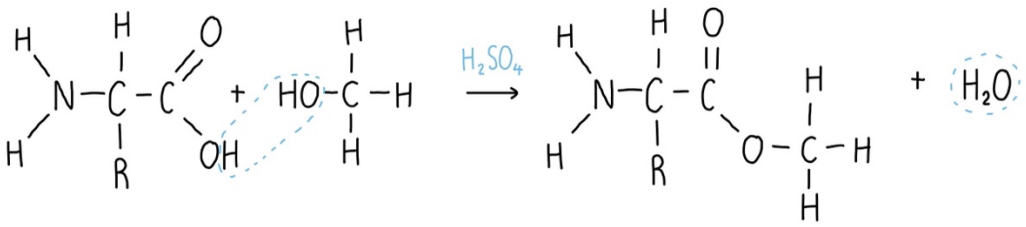
- Amino acids consist of a central carbon atom attached to four different groups: an **amine** group, a **hydrogen** atom, a **carboxyl** group and a **variable 'R' group**.
- They have the general formula **$RCH(NH_2)COOH$**.
- Amino acids can act as both **acids and bases** because they contain the acidic carboxylic acid group (COOH) and the basic amine group (NH_2).
- When amino acids react with **alkalis**, they form a salt and water.



- When amino acids react with **acids**, the amino group accepts a proton to form a positively charged ion. This forms a salt with the negative non-metal from the acid.

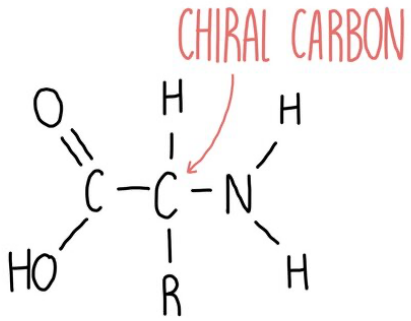


- Amino acids (like carboxylic acids) react with **alcohols** to form **esters** in the presence of a sulfuric acid catalyst.

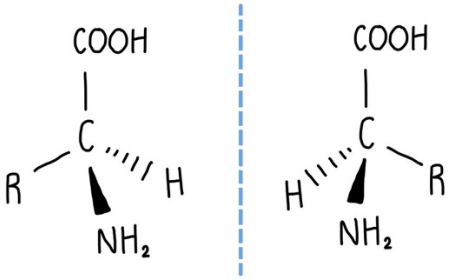


Chirality

- A **chiral carbon** is a carbon atom which has **four different groups attached**.
- Amino acids (except glycine) are chiral molecules because their central carbon is attached to four different groups.



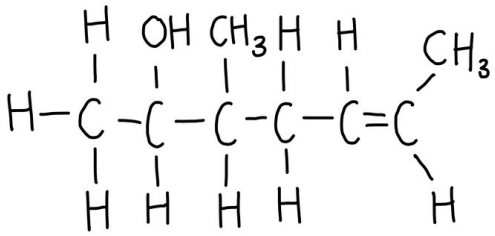
- Chiral compounds can be arranged in two different ways which are **non-superimposable mirror images** of each other.
- These are known as **optical isomers** or enantiomers.
- Optical isomers **rotate plane-polarised light** in **different directions** – one isomer rotates it clockwise and the other rotates it anticlockwise.



- Some chiral compounds may have **more than one chiral centre**.
- For each chiral centre, two enantiomers are formed, which means that if there are two chiral centres, there will be four optical isomers and if there are three chiral centres, there will be six optical isomers.

Worked example – identifying the number of isomers

How many stereoisomers are formed from 3-methylhept-5-en-2-ol, shown below?



- First identify how many chiral centres there are (atoms attached to four different groups). In this case, it's 2.
- Multiply by 2 to get the number of optical isomers. 2 x 2 = 4.
- Identify the number of double bonds (in which each carbon is attached to 2 different groups) to identify the number of E/Z isomers. Multiply that number by two.
- 1 double bond (with each C=C attached to 2 different groups) x 2 = 2 E/Z isomers.
- Total number of stereoisomers = 6.