

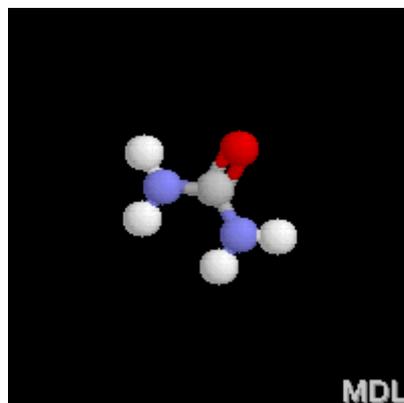
# Excretion and the liver

## Excretion in mammals

Excretion is the removal of potentially harmful or toxic substances from the body. These substances are usually waste materials produced by complex chemical reactions taking place in living cells. Enzymes catalyse the reactions. Excretion usually refers to the removal of nitrogenous (nitrogen-containing) substances such as urea.

## The part played by the liver

The liver is a complex organ. It performs over 500 different functions. Two of these are the control of amino acid concentration and detoxification. Urea is produced in the liver and is a metabolite (breakdown product) of amino acids. Ammonium ions are formed in the breakdown of amino acids. Some are used in the biosynthesis of nitrogen compounds. Excess ammonium ions are converted to urea.



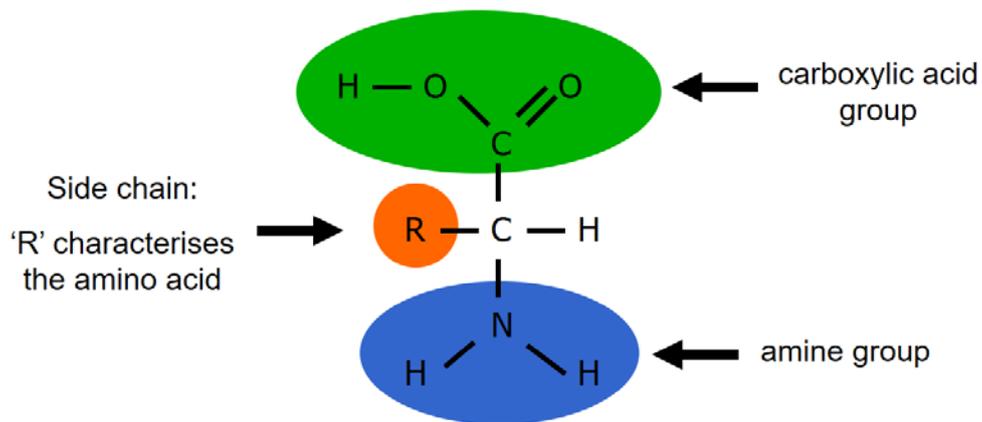
*Urea*

## Regulation of amino acids

### Amino acids

The general molecular formula of an amino acid is  $\text{RCH}(\text{NH}_2)\text{COOH}$

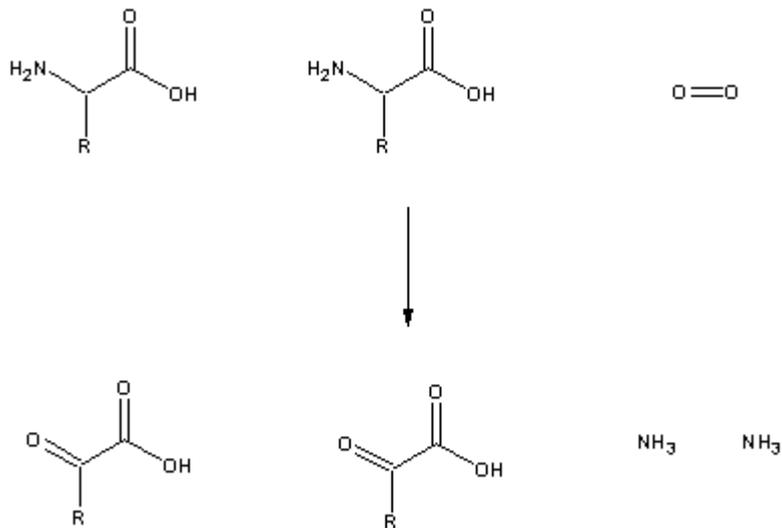
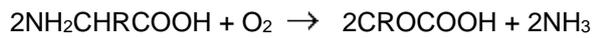
However, it's easier to 'see' the bonds that are present by writing its structural formula:



The body is unable to store proteins or amino acids, the metabolites of proteins. When excessive amounts of protein are ingested, the excess amino acids produced from digesting proteins are transported to the liver from the small intestine.

When amino acids are absorbed by liver cells a series of chemical reactions begins. The amino acid is oxidised in the presence of an enzyme catalyst. At the same time the amine group,  $-\text{NH}_2$ , and a hydrogen atom,  $\text{H}$ , are removed from the main structure of the amino acid. The important product of this reaction is ammonia. The amine group is reduced to ammonia by the addition of a hydrogen atom. This process is called **deamination**. The non-nitrogenous portion of the molecule is converted to carbohydrates or fats.

The overall equation for deamination of an amino acid in the liver is:

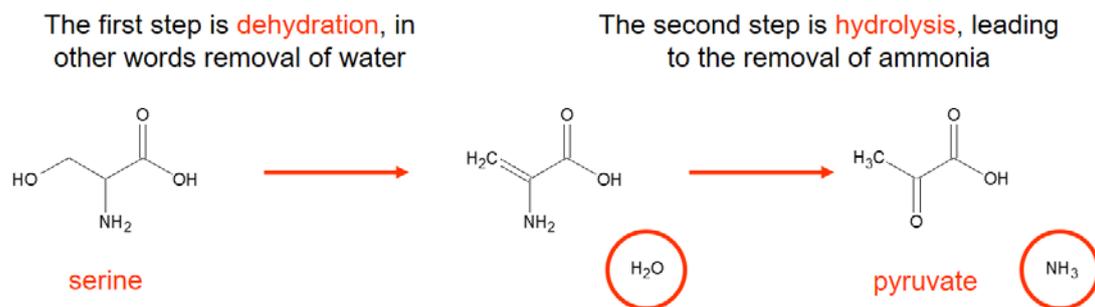


The amino acids serine and threonine can be deaminated directly. For example,



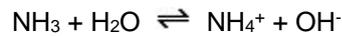
## Deamination of amino acids

The amino acids serine and threonine can be deaminated directly,  
for example: serine  $\rightarrow$  pyruvate + ammonia

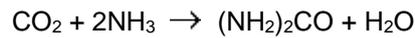


## The liver - the detoxification organ

Ammonium ions exist in aqueous solution in dynamic equilibrium with ammonia molecules



Ammonia is highly toxic in the body and therefore cannot be allowed to accumulate. With the help of specific catalysts in the liver cells carbon dioxide reacts chemically with the ammonia molecule,  $\text{NH}_3$ . The less toxic nitrogenous compound urea is produced together with water.



This series of reactions is called the **ornithine cycle**. The urea and water are released from the liver cells to the bloodstream and transported to the kidneys where the blood is filtered and the urea is passed out of the body in the urine. Urea is very soluble and a small molecule, so it is relatively easily passed out by the kidneys as a solution in water.

## Test your knowledge

[Take quiz on Excretion](#)