3.11 Coenzymes and Prosthetic Groups

The importance of cofactors and coenzymes in enzyme-controlled reactions

Many enzymes rely on **cofactors** in order to function. These are *non-protein* substances which are present because some enzymes can only catalyse a reaction if they are present. A cofactor ensures that an enzyme-controlled reaction is taking place at an appropriate rate.

Cofactor - a substance which is present to ensure an enzyme-controlled reaction takes place at an appropriate rate

Coenzyme - a molecule which binds to the active site with the substrate and helps the reaction

A **coenzyme** is a non-protein molecule which also binds to the active site of an enzyme for a short period of time, either just before the substrate does or at the same time. A coenzyme has a part in the catalytic reaction, and (like the substrate) is changed in some way – but unlike a substrate, a coenzyme is recycled back to be used again after the reaction.

The role of coenzymes is to carry chemical groups between enzymes so that enzyme-controlled reactions may take place in sequence.

Vitamin B_3

You are required to know about one example of coenzymes in practice for the exam

Vitamin B_3 is used in the process of breaking down fats and carbohydrates to release energy. The vitamin is used to make a coenzyme that is required for **pyruvate dehydrogenase** (an enzyme which catalyses a reaction involved in respiration) to function properly. Normal growth and development cannot proceed without vitamin B_3 and a disease known as **pellagra** forms if there is a deficiency of this vitamin in the diet

A coenzyme which is a permanent part of an enzyme is called a **prosthetic group**. They are vital for the function of an enzyme, as with coenzymes, but a prosthetic group also contributes towards the protein's 3D shape and other properties.

Carbonic anhydrase

You are required to know about one prosthetic group and its enzyme for the exam

The enzyme **carbonic anhydrase** contains a zinc-based prosthetic group. This enzyme is a vital component in red blood cells, where it is involved in catalysing the combination of water and carbon dioxide to give carbonic acid. This is an important reaction that enables carbon dioxide to be transported in the blood

In a few enzyme-controlled reactions, it is the presence of certain **ions** that can increase the reaction rate. Ions may combine with the enzyme or the substrate. The ion binding makes the formation of an enzyme-substrate complex happen more easily, because it can affect the *charge distribution* or the end shape of the complex.

Amylase

You are required to know about one inorganic ion cofactor for the exam

Amylase catalyses the breakdown of maltose molecules. This enzyme will function properly only if **chloride ions** are present. Without the chloride ions, amylase cannot catalyse the reaction