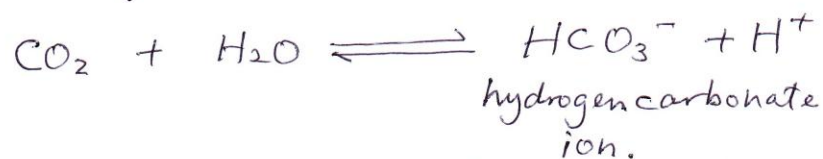


## Zinc as an enzyme cofactor

Carbonic anhydrase is the enzyme present in red blood cells which is responsible for removing carbon dioxide from the blood.

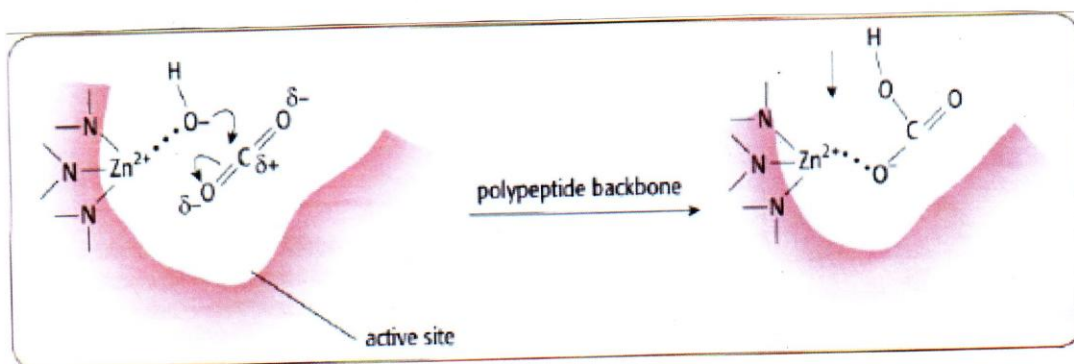
It accelerates the rate of the reaction by a factor of about 1 million.



The enzyme contains  $\text{Zn}^{2+}$  as a prosthetic group at the active site.

The  $\text{Zn}^{2+}$  is bound to the enzyme as part of a complex using N atoms from amino acid side-chains as ligands.

$\text{Zn}^{2+}$  ion helps provide a nucleophile in this reaction.



$\text{Zn}^{2+}$  ions help catalyse the conversion of carbon dioxide to hydrogencarbonate ions.

The mechanism of this reaction is:

- the high charge density on the  $Zn^{2+}$  ion assist the breakdown of a water molecule to form  $OH^-$  and  $H^+$ .
- the  $OH^-$  ion is a nucleophile, it attacks the  $CO_2$  molecule.
- $HCO_3^-$  is produced ( $CO_2 + OH^- \rightarrow HCO_3^-$ )
- the  $HCO_3^-$  ion is released and a further water molecule binds to the zinc.

### Exercise

The enzyme carbonic anhydrase converts carbon dioxide to hydrogen carbonate ions.

- Which metal is the prosthetic group in carbonic anhydrase?
- Write the equation for the reaction catalysed by carbonic anhydrase.
- The metal present induces the ionisation of a water molecule to produce a hydroxide ion. This attacks the carbon dioxide to form the hydrogen carbonate ion.
  - What type of reagent is the hydroxide ion acting as in this reaction?
  - Use a 'curly arrow' to suggest the mechanism for the formation of the hydrogen carbonate ion.

Workings

a. zinc



c. i) nucleophile

