

### Enzymes

**Enzyme** Biological molecules (**proteins**) that act **as catalysts** and **help complex reactions**.

are specific to their substrates and each enzyme has its own optimum pH

**Substrate** Material upon which an enzyme acts.

**Enzyme inhibition** important in normal metabolism for control of pathways.

### Reversible inhibitor

**competitive inhibition** (Raises  $K_m$  only) Same size and shape with the substrate

**noncompetitive inhibition** (Lowers  $V_{max}$  only) inhibitor doesn't mind whether there is a substrate or not. but when the inhibitor binds, it switches off catalysis.

**uncompetitive inhibition** (Lowers  $V_{max}$  and  $K_m$ ) the inhibitor can ONLY be on the surface of the enzyme if the substrate is there.

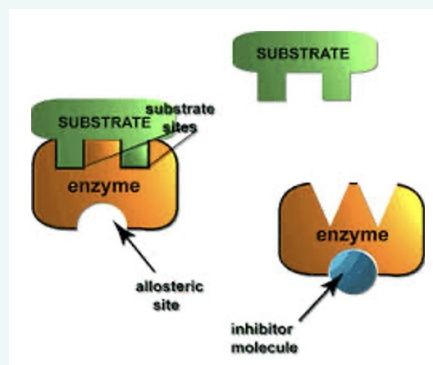
**Irreversible inhibitor** acts by reacting with the enzyme protein, usually at the active site(substrate site), to permanently block activity.

$V_{max}$  is the maximum rate of an enzyme catalysed reaction i.e. when the enzyme is saturated by the substrate.

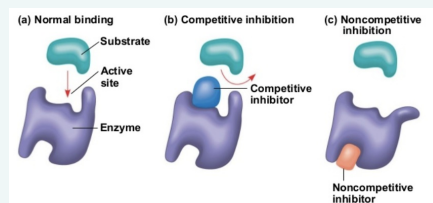
$K_m$  is measure of how easily the enzyme can be saturated by the substrate.

$K_m$  and  $V_{max}$  are constant for a given temperature and pH and are used to characterise enzymes. They can be used to identify types of inhibitors i.e. competitive, non-competitive and uncompetitive.

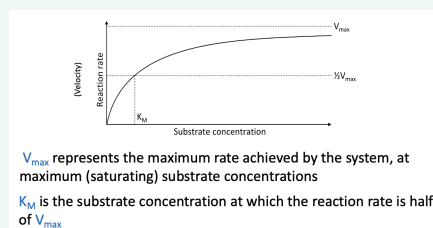
### Allosteric site



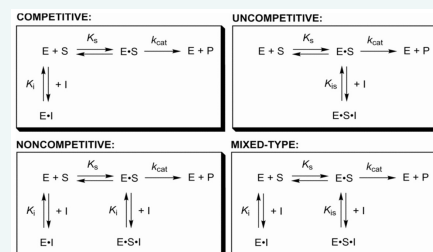
### Normal binding



### Enzyme kinetics



### Reversible inhibition



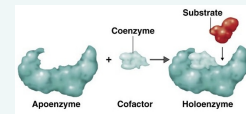
### Enzyme in human digestion

Three main types of enzymes in human digestion:

- Amylases break down carbohydrates**  
 Example: salivary amylase  
 Substrate: starch    Product: maltose  
 Source: mouth (salivary glands)  
 Optimum pH: 7-7.8
- Proteases break down polypeptides**  
 Example: pepsin  
 Substrate: polypeptides    Product: amino acids  
 Source: stomach  
 Optimum pH: 2
- Lipases break down fats and lipids**  
 Example: pancreatic lipase  
 Substrate: triglycerides    Product: fatty acids & glycerol  
 Source: pancreas, delivered into small intestine  
 Optimum pH: 7.2 - 7.5

### free energy, G

### with co-enzyme



### CoFactor

In the case of **metal ion cofactors**

**Stabilise** the structure, not directly involved in the chemistry  
 Ca<sup>++</sup> with some proteinases

**part of substrate** Mg<sup>++</sup>-ATP with some kinases

**part of active site** Zn<sup>++</sup> in alcohol dehydrogenase

### Organic cofactors

**coenzymes** they do come on and off like other substrates (NAD<sup>+</sup>)

**prosthetic groups** a cofactor that forms a permanent part of the enzyme's active site.

Doesn't come on and off in a catalytic cycle (FAD, PLP)

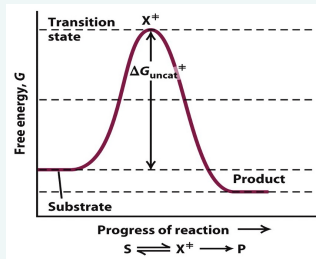
### NAD<sup>+</sup> is both a coenzyme and a substrate

Why use coenzyme in one case and not in the other case?

Metabolic point: NAD is one of a range of cofactor substances that is present in small concentration

They turn over and over again to process a large amount of substances

Pathway is to process large amount with tiny amount of coenzyme



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