Industry

Denature

pH

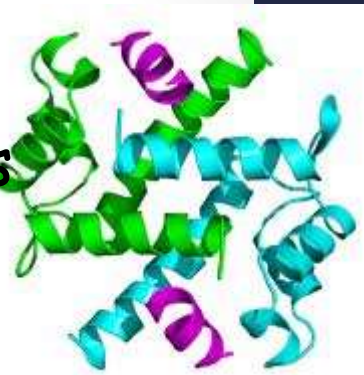
B2.3 Enzymes

Temperature

Enzymes

Biological catalysts

Proteins



- Proteins are made from long chains of smaller molecules called amino acids. These long chains are folded into particular shapes.
- Proteins are built up in cells when monomers called amino acids join together. Lots of amino acid molecules → a protein molecule.
- The long chains of amino acids fold to give each type of protein molecule a specific shape. Proteins act as:
    1. **Structural components** of tissues (such as muscles)
    2. **Hormones** (such as insulin)
    3. **Antibodies** (part of the body's immune system)
    4. Biological catalysts (**enzymes**)

What are enzymes?

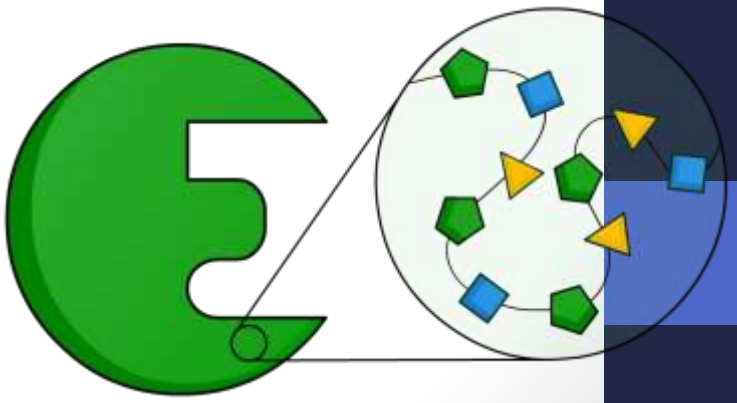
Enzymes can be found inside cells. They are made from long chains of proteins and are used in chemical reactions.

Enzymes speed up chemical reactions and are therefore known as biological catalysts.

There are 2 types of enzyme:

- Some enzymes break large molecules up into smaller ones.
- Others join small molecules up into larger ones.

Each type of enzyme has a unique shape.

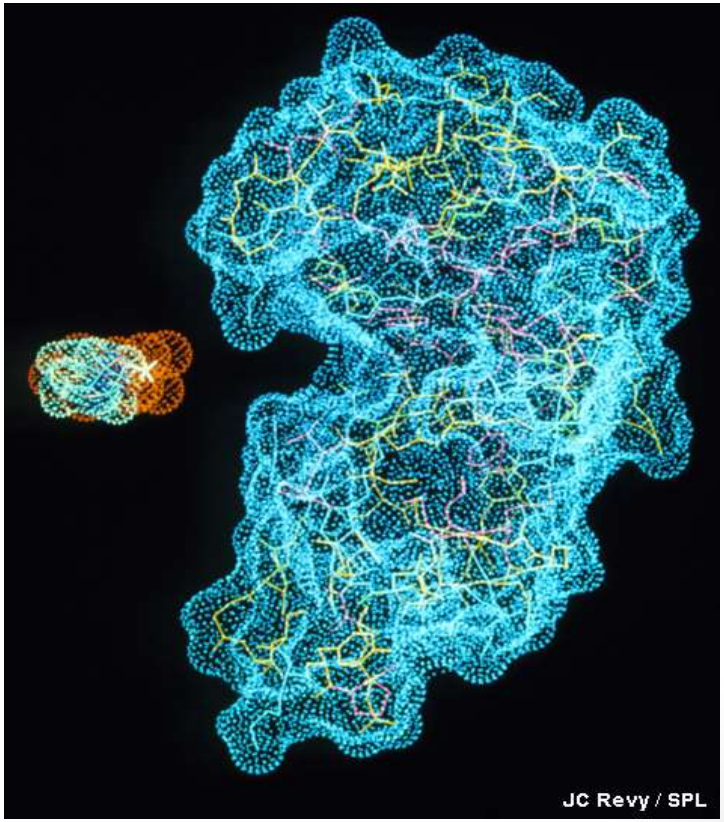


Why are enzymes so specific?

Enzymes are very specific about which reactions they catalyze. Only molecules with exactly the right shape will bind to the enzyme and react. These are the **reactant**, or **substrate**, molecules.

The part of the enzyme to which the reactant binds is called the **active site**.

This is a very specific shape and the most important part of the enzyme.



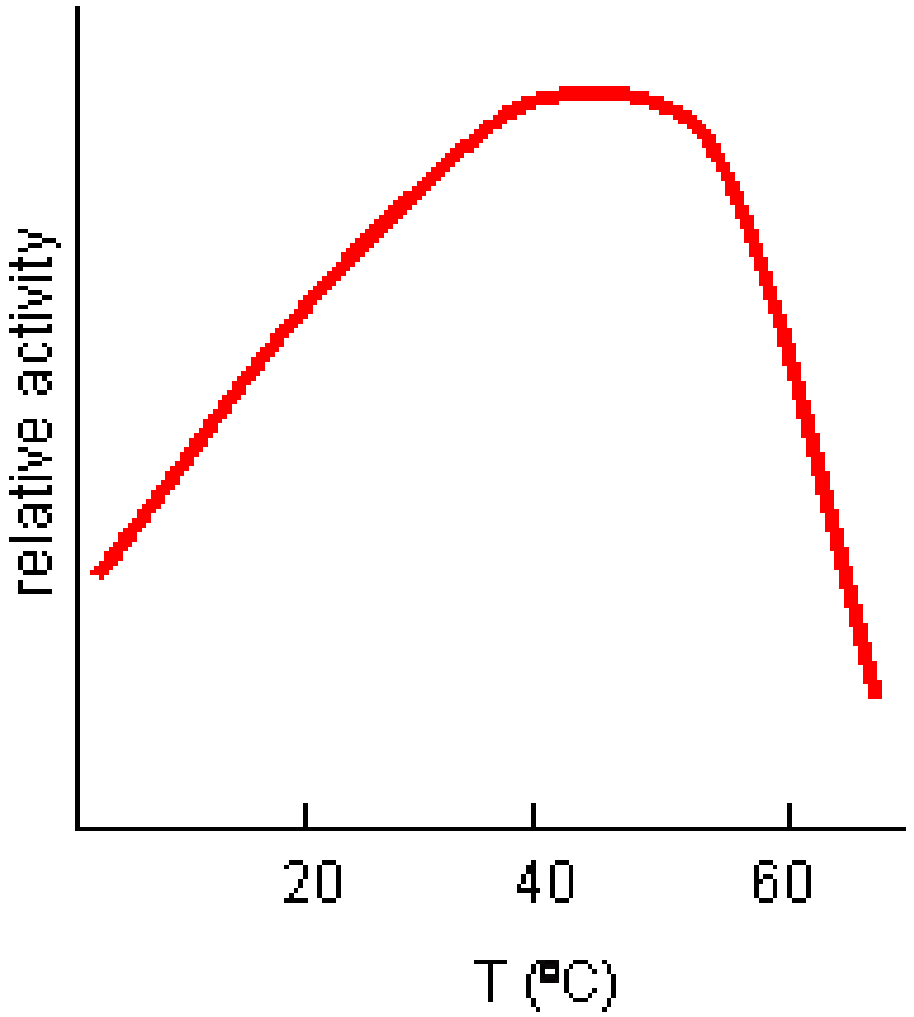
What happens at the active site?

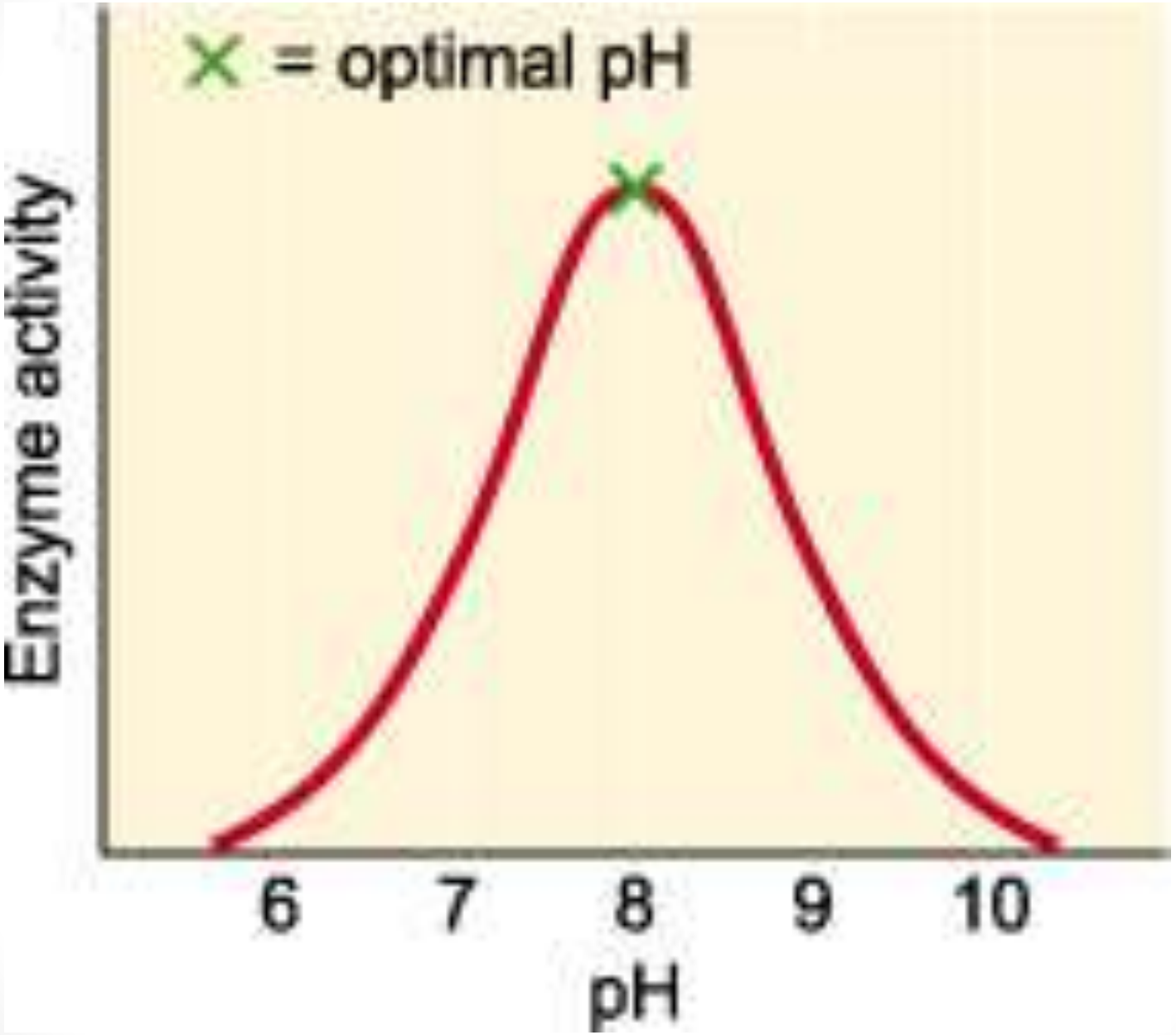
In the same way that a key fits into a lock, so a substrate is thought to fit into an enzyme's active site. The enzyme is the **lock**, and the reactant is the **key**.

Enzymes

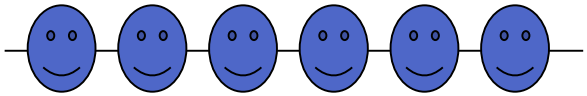
- Enzymes like specific conditions in which to work most efficiently – this can include a specific (optimum) **temperature and pH level**.
- Human enzymes work best at 37°C.
- As temperatures move away from the optimum, the rate at which the enzyme works slows down.

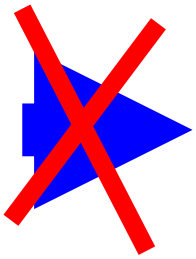
Temperature and enzyme activity



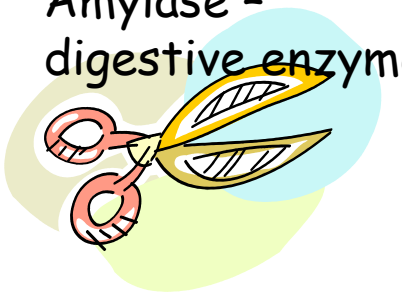

X = optimal pH
Enzyme activity
6
7
8
9
10
pH

Starch molecules – large and branched

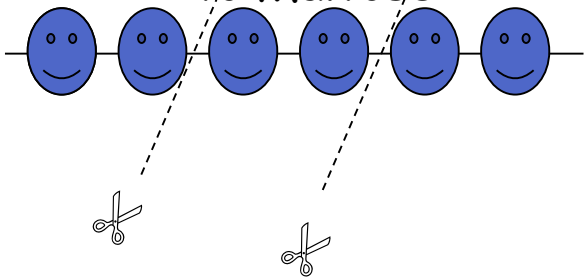


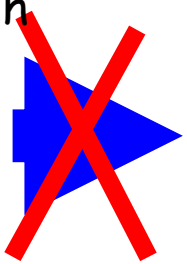


Amylase – digestive enzyme

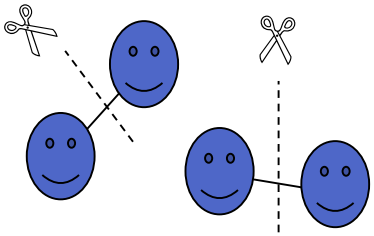


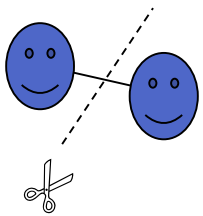
Breaks down starch to Maltose



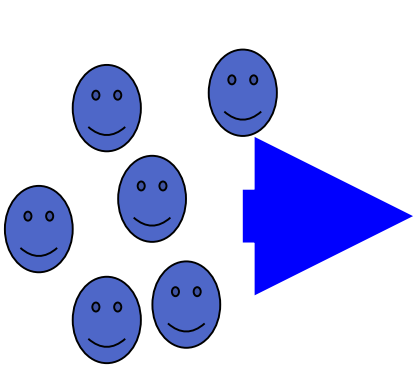


Still too big!



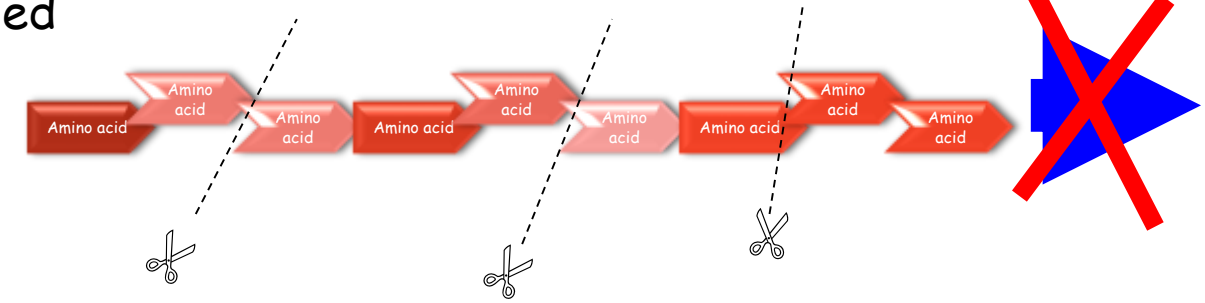


Maltase in the small intestine breaks down maltose to glucose units



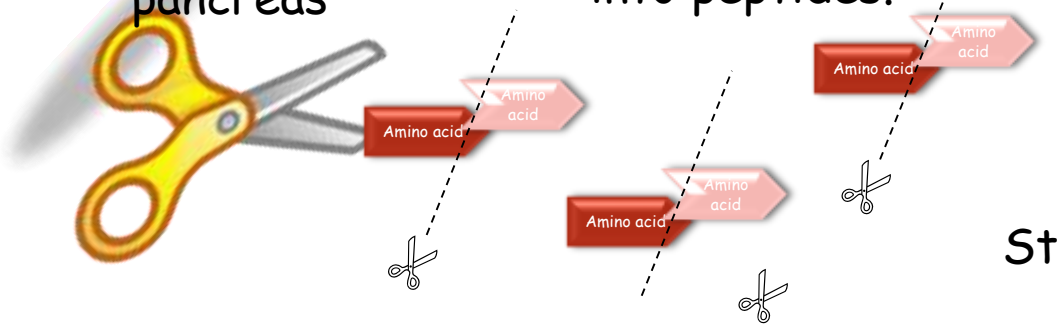
Readily absorbed.

Proteins – large and branched



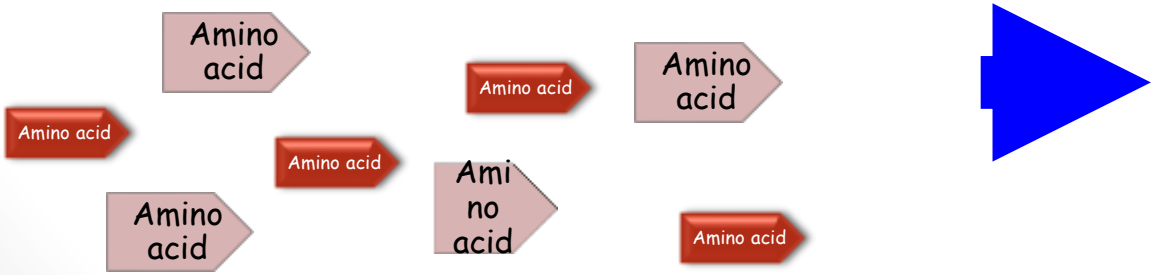
Trypsin from the pancreas

Breaks down proteins into peptides.

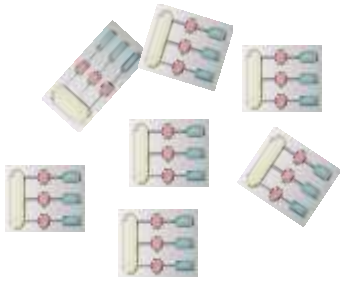


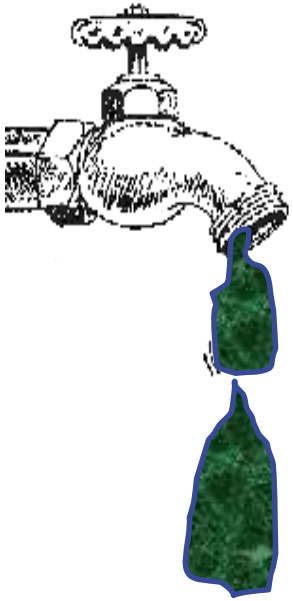
Still too big!

Peptidase from the small intestine



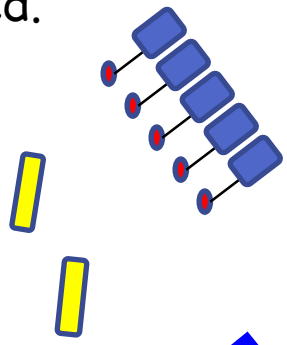
Fats
&
Oils

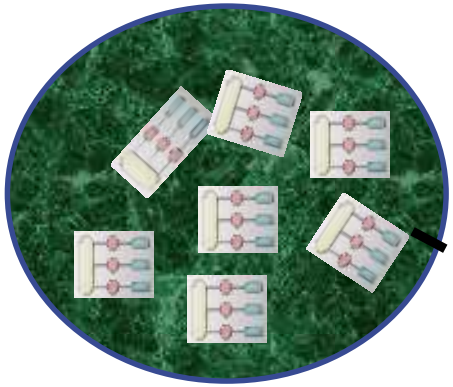




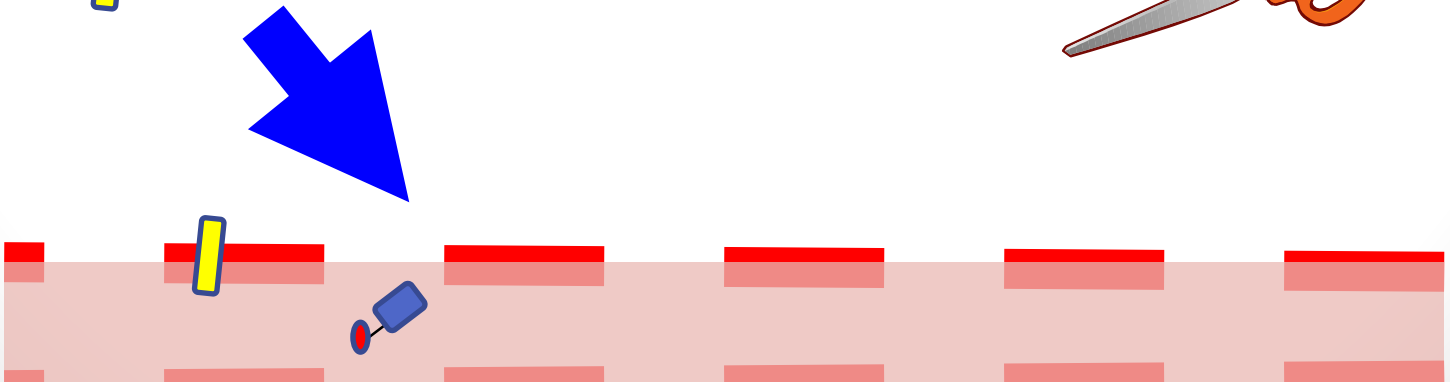
Bile from the liver mixes with the 'fat' to make an emulsion. This increases SA.

Fatty acids and glycerol which is easily absorbed.



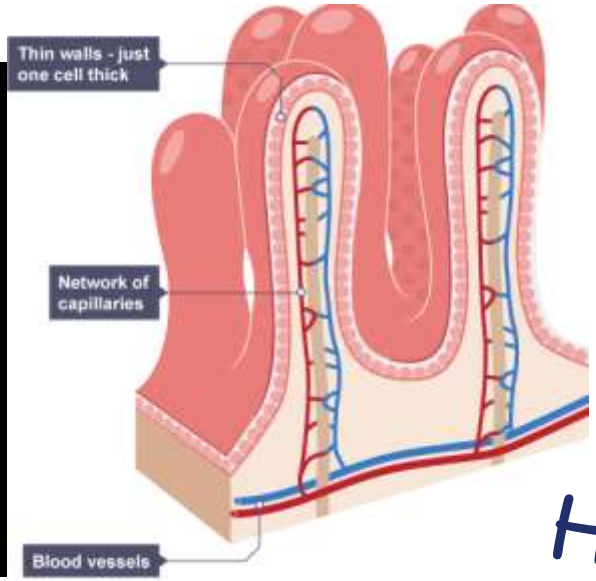


Lipase from the pancreas breaks down the fats to...



Adaptations

Finished?!
~~Awesome~~ ☺
Describe how fat bile emulsifies fat



How are the small intestine and stomach adapted for their function?

Enzymes in industry

- Protease is used in baby foods to break down proteins into amino acids. This helps babies digest their food and stops them developing allergies to cow's milk.
- Lactase converts starch syrup into sugar syrup by breaking down starch into glucose. Sugar syrup is more valuable and used in things like sports drinks.
- Biological detergents contain proteases and lipases that break down proteins and fats in stains. They work at a lower temperature so you don't need to heat the washing as much, saving energy.
- Isomerase is used to convert glucose syrup into fructose syrup. Fructose syrup is sweeter, so you don't need to use as much and therefore is a healthier option.

Advantages

- In industry, many chemical reactions need high temperatures and pressures to make them happen fast enough to produce products.
- All that energy and specialist equipment costs a lot of money.

Enzymes are the answer!

They catalyse reactions at relatively low temperatures and normal pressures = fairly cheap.

- Pure enzymes use the substrate (the substance they bind to) efficiently.

Disadvantages

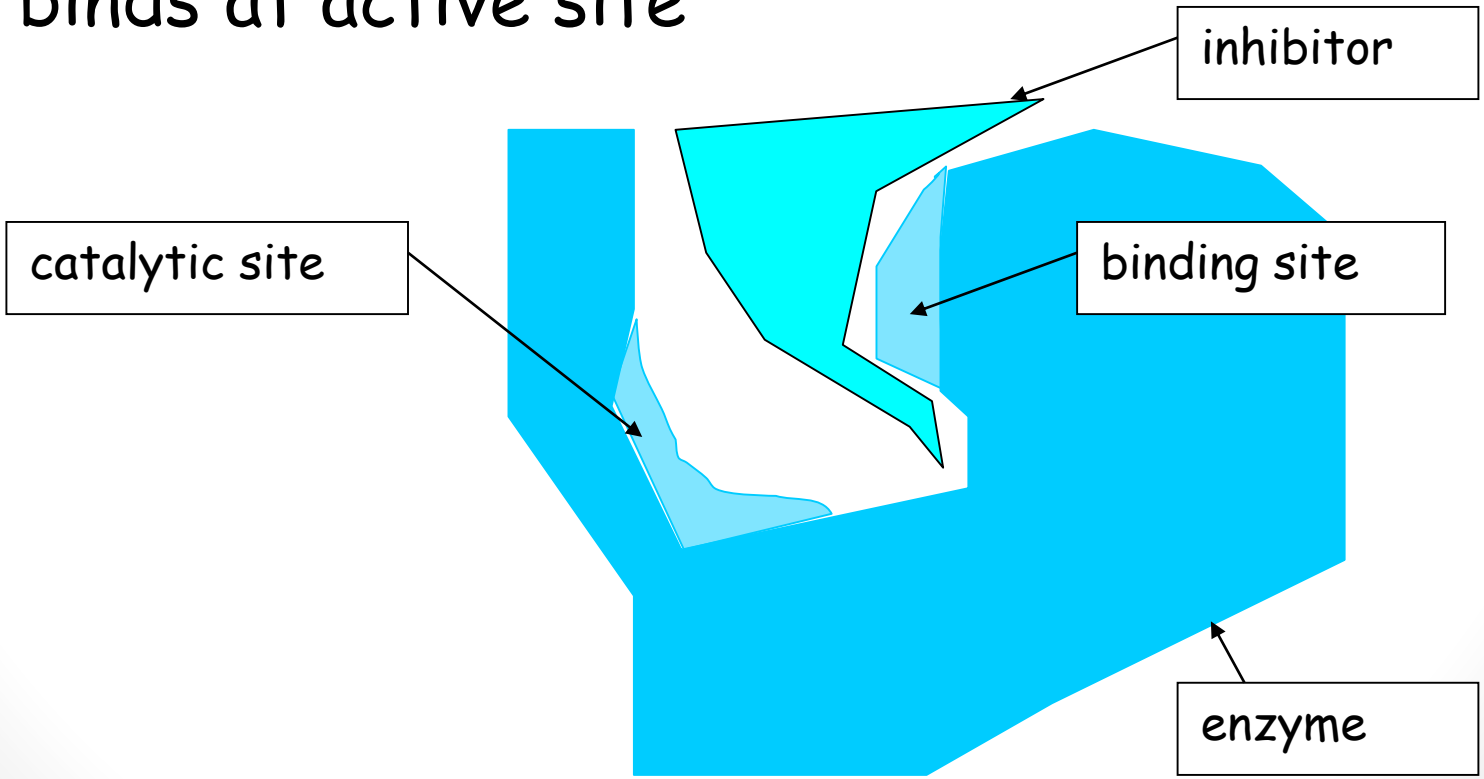
Very sensitive to the conditions they are in. For most enzymes the temperature must be below 45°C. The pH must also be controlled to suit the enzyme involved. If either is not controlled the enzymes could denature. This costs money.

- Whole microbes can be used as they produce enzymes however, they need food and oxygen supplies and the waste products need to be removed.
- Pure enzymes are expensive to produce.

Enzyme Inhibition (1)

Competitive

- similar to substrate
- binds at active site



Enzyme Inhibition (2)

Non-competitive

- not necessarily similar to substrate - may even be a metal
- does not bind at active site
- changes the shape of enzyme which prevents substrate binding

Exam questions