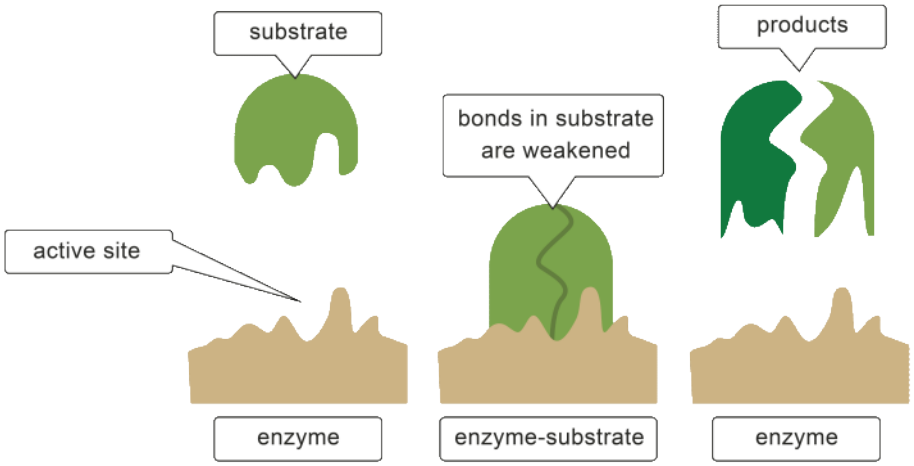
The Complete GCSE Guide to Enzymes

Introduction:

Enzymes **speed up** reactions by **providing an alternative route** for substrate breakdown. In this process, **substrates bind to the active site** of the enzyme, which is **unique** to each enzyme and specific substrate.



This is known as the '**lock-and-key**' model, where a specific substrate 'key' will only fit in its complimentary enzyme 'lock'.

Digestive Enzymes:

There are three categories of digestive enzyme, which have been summarised below:

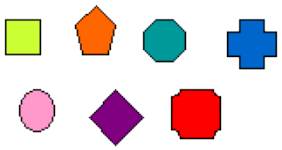
Enzyme	Substrate	Product	Produced in
Protease	Proteins	Amino Acids	Small intestine Pancreas Stomach
Lipase	Lipids (fats)	Glycerol and fatty acids	Pancreas
Carbohydrase	Carbohydrates	Sugars	Small intestine Pancreas

			Salivary glands

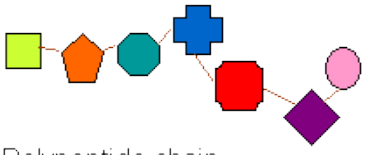
Protease:

Protease **breaks down proteins into amino acids** (this is what all proteins are made up of!). This is a process which begins in the stomach and is continued in the duodenum (first part of the small intestine) before being completed in the ileum (last part of the small intestine).

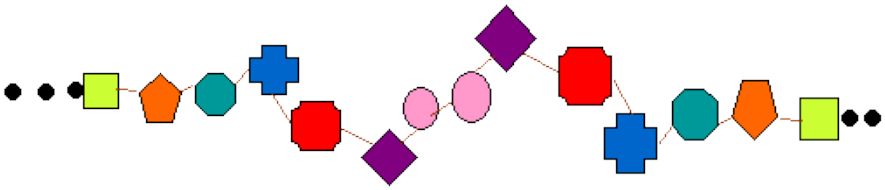
In the stomach, protease is produced by the **gastric glands** within the stomach lining, the **pancreas** produces protease for the duodenum and the **walls of the small intestine** produce the enzyme for the ileum.



Amino acids



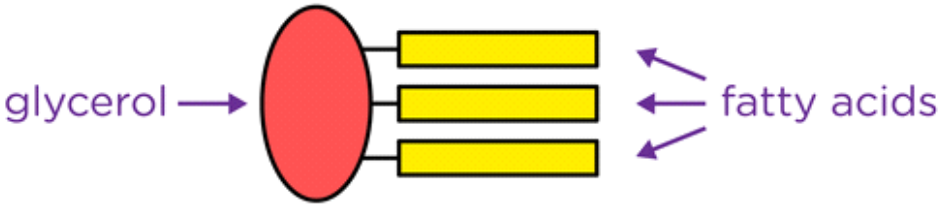
Polypeptide chain - a short chain of amino acids



A protein - a long chain of amino acids. The sequence of amino acids will determine the proteins shape & therefore function.

Lipase:

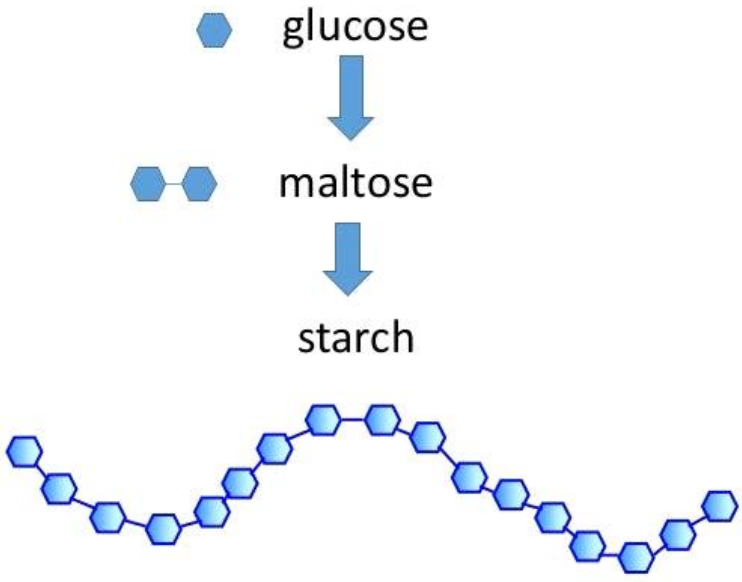
Lipase **breaks down lipids into glycerol and fatty acids** (which make up lipids). This process takes place in the duodenum and lipase is produced by the **pancreas**.



Carbohydrase:

Carbohydrase **breaks down carbohydrates into sugars**, a notable example is **amylase** which **breaks down starch** (a carbohydrate) **into glucose** (a sugar). This process begins in the mouth and is continued in the duodenum, breaking starch down to **maltose** (a sugar made of two glucose molecules). It is completed in the ileum, where maltose is finally broken down into two glucose molecules.

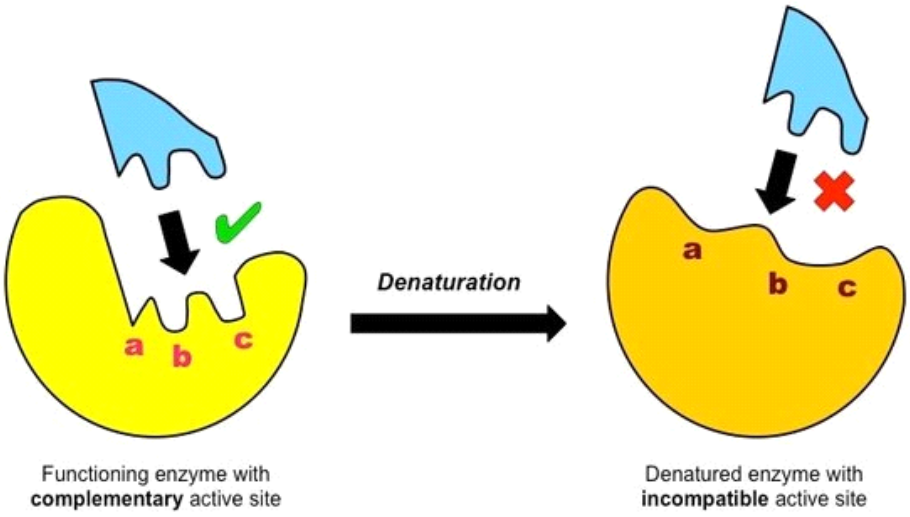
Amylase used in the mouth is produced in the **salivary glands** whilst the **pancreas** produces for the duodenum. Amylase for the ileum is made in the **small intestine walls**.



Optimum Conditions:

Enzymes are made of proteins, in turn made up of amino acids. This means that they can be broken down under harsh conditions, when an enzyme is broken down it is

denatured. Denatured enzymes no longer function as their active site has changed shape and does not fit the substrate.



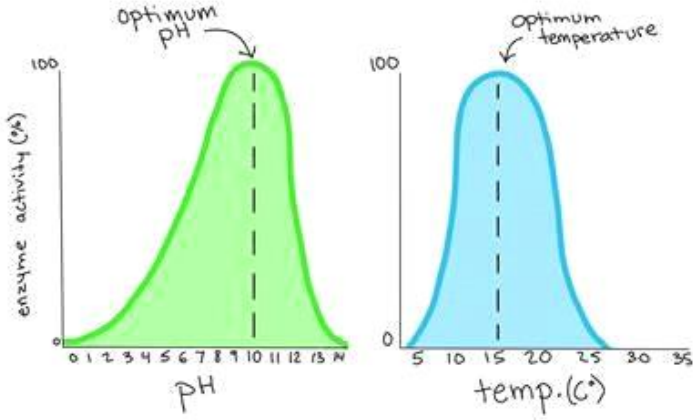
Temperature:

Enzymes in the body function best (**optimally**) at the internal body temperature of **37°C** and will **denature** at temperatures **over 40°C**.

pH:

The pH changes throughout the body, for example the stomach is acidic due to secretions of hydrochloric acid (or gastric acid, pH 1.5 - 3.5) compared to the duodenum which has a higher Ph due to secretions of sodium hydrogen-carbonate (pH 8.5, to create a pH of 5.5). Here is the optimum pH of some enzymes:

Enzyme	Optimum pH
Salivary Amylase	6.8
Stomach Protease	1.5-2.0
Pancreatic Protease	7.5-8.0



Maintaining pH:

It is important that the optimum pH is maintained within different parts of the digestive system, this is done not only through the release of **acids** and **bases** but also through the **liver**.

The liver produces **bile**, containing sodium hydrogen-carbonate - an alkali that acts to increase the pH of the duodenum by neutralising gastric acid. This is an important process as it means that pancreatic enzymes (produced by the pancreas) can act at their optimum pH.

Bile is stored after production in the **gall bladder** before release.

Lipid Emulsification:

Bile also **emulsifies** lipids, breaking them down into small molecules spread throughout the solvent. This solution is called an **emulsion** and provides a higher surface area for optimal lipase action in the duodenum.