iLearn Biology Podcast 3: ENZYMES

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This third podcast will cover enzymes.

Enzymes are not well understood, but are very important.

The digestive enzymes that are secreted by cells into the stomach and lumen of the intestine account for only a tiny fraction of the vital enzymes in the body. Most enzymes are made by cells for use within the cell in which they are made.

Just about every important biochemical process that happens in a cell is controlled by enzymes – cellular respiration, DNA replication, the synthesis of polymers from monomers, even the production of enzymes themselves.

Definitions

- **Metabolism**: All the chemical reactions happening in a cell.
- **Reactants and substrates**: Chemicals that go into a chemical reaction.
- **Products**: Chemicals at the end of the reaction.
- **Metabolic pathway/biochemical pathway**: A series of chemical reactions. The product of each reaction becomes the substrate for the next reaction.
- **Catalyst**: Any chemical that speeds up a chemical reaction by lowering the activation energy. Any reaction (even one that releases energy) requires an input of energy to start it off. An enzyme reduces the amount of energy needed to do that. A catalyst is not used up in the reaction. It doesn't become part of the product.

What is an enzyme?

An enzyme is a catalyst that is made of protein.

Names of enzymes normally end in '-ase'. Those that don't tend to be enzymes that have been known for a long time.

Characteristics of enzymes

- Only a small amount of enzyme is needed to do a big job. They are not used up in the reaction.
- An enzyme doesn't change the direction of the reaction, but does speed up the reaction.
- An enzyme won't change the final amount of product formed.
- Enzymes are *very specific* to their substrate. There is a high affinity between the active site of the enzyme and the binding site of the substrate – the active site is complementary to the binding site of the substrate molecule. This is an example of *molecular specificity*.

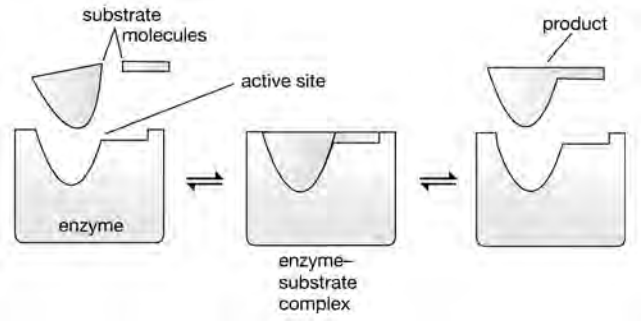

Figure 1
The lock-and-key model.

- There are two models for enzyme action: the lock-and-key model and the induced-fit model. In the more modern induced-fit model, the active site changes shape to exactly fit the substrate.

Things that affect the rate at which an enzyme functions

pH

- The pH scale is 1–14, where 1 is very acidic, 14 is very basic, 7 is neutral.

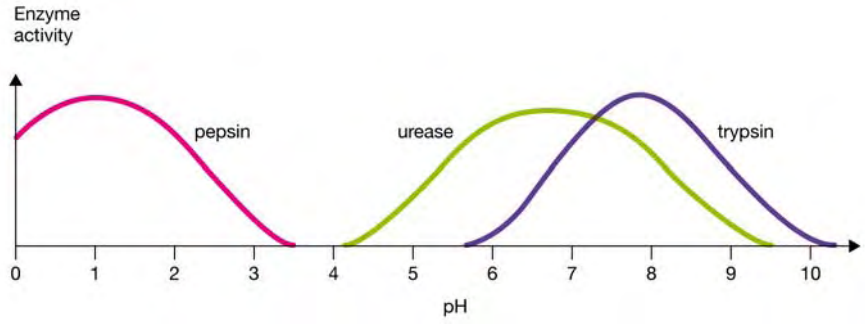

Figure 2
Enzyme activities in relation to pH values. The optimum pH for an enzyme is that at which the enzyme shows maximal activity.

- Each enzyme has an optimum pH (enzymes are very sensitive to pH).
- Different enzymes have different optimum pH values. For example, in the stomach the enzyme pepsin has a low optimum pH, so the stomach produces acid to maintain this low pH. The enzymes of the pancreas need a higher pH to work.
- Changing pH affects enzyme function because hydrogen bonds break, and therefore the 3D shape of the enzyme changes.

Temperature

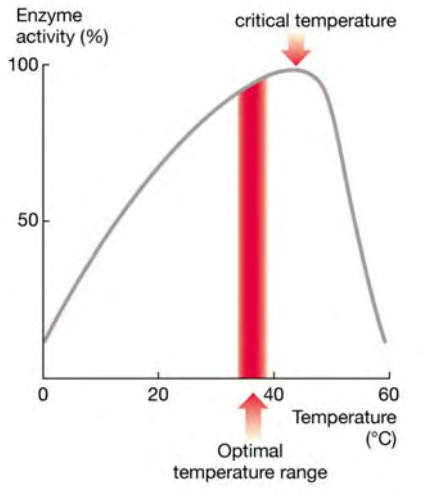

Figure 3
The rate of enzyme activity increases with increasing temperature until the enzyme begins to break down (denature), in this case at approximately 45°C.

The effect of temperature on enzyme activity is more complicated than that of pH.

- If the critical temperature is reached, then the enzyme will denature. The tertiary structure of the protein is changed permanently and cooling it back down again won't restore the enzyme's function.
- The optimum temperature for humans is 37ºC, birds 40ºC, some fish 10ºC, the bacteria *Thermus aquaticus* 80ºC!
- For humans, at 40ºC we feel like we are going to die and a temperature of 42ºC is fatal – our enzymes begin to denature.
- Chemical reactions go faster at higher temperatures.
- Enzymes are not denatured when it is too cold – only when it is too hot.

Inhibitors

- An inhibitor is any chemical that changes the shape of the active site of the enzyme so that it has a lower affinity for substrate.
- There are various ways that inhibitors work.
- Cells produce inhibitors to slow the rate of reaction where necessary.
- Most toxins (e.g. sarin gas, cyanide, snake venom) work as inhibitors for enzymes.

Cofactors

- Cofactors act by fitting into the active sites of enzymes to make substrates fit better. They increase an enzyme's affinity for a substrate.
- Organic cofactors are called **coenzymes**, e.g. vitamins.

Enzyme concentration

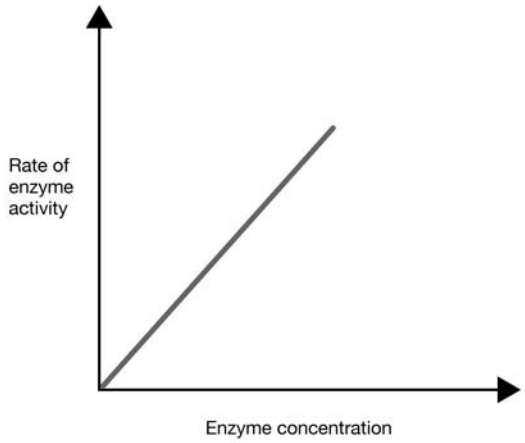

Figure 4
The rate of enzyme activity increases with increasing enzyme concentration.

- Increased enzyme concentration will increase the rate of reaction.
- Increased enzyme concentration will *not* increase the amount of product formed.

Substrate concentration

- Increased substrate concentration will increase the amount of product formed.
- Increased substrate concentration will increase the rate of reaction up to the point when the enzyme is **saturated** with substrate.

Relevant past exam questions

VCE 2006 Biology Exam 1 Multiple Choice Question 19

VCE 2006 Biology Exam 1 Multiple Choice Question 25

VCE 2004 Biology Exam 1 Multiple Choice Question 7

VCE 2001 Biology Exam 1 Short Answer Question 9

HSC 2003 Biology Exam Multiple Choice Question 7

HSC 2003 Biology Exam Short Answer Question 31 (part c)

Contact Andrew Douch at adouch@gmail.com
Please specify if you wish to remain anonymous. However, only first names of students will be used on the podcast.

