Biology Notes 2013

Biotechnology

Introduction

Biotechnology is the industrial, medical, environmental and commercial application of biological materials. It usually involves the use of microorganisms, enzymes and genetic engineering. Biotechnology has beneficial or destructive purposes.

History of Biotechnology

Ancient biotechnology include making of cheese, bread, vinegar, alcohol, and cross-breeding of animals.

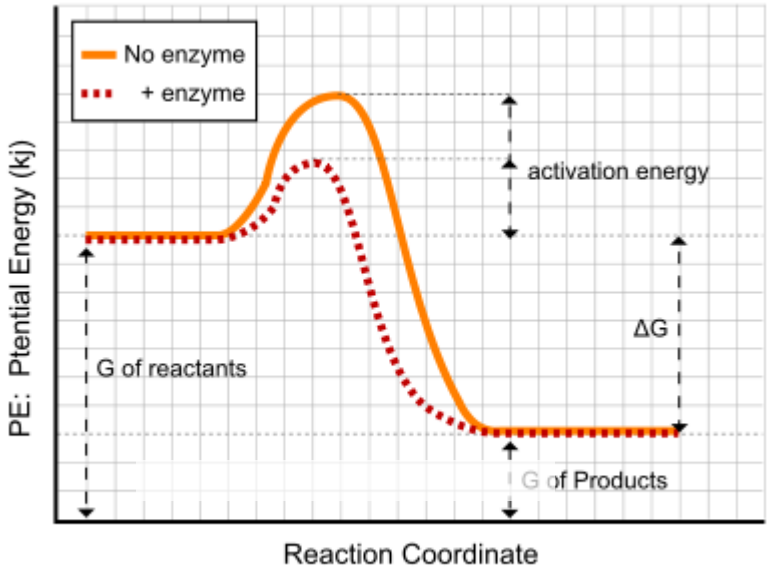
Classical biotechnology include discovery of genetics and antibiotics.

Modern Biotechnology include discovery of structure of DNA, genetic engineering, cloning, diagnosing and treating diseases, increasing food supply, detergent, DNA fingerprinting, cleaning oil spills.

What may biotechnology hold in the future?

Enzyme Biotechnology

Enzymes are industrial catalysts. They are highly specific; are also efficient in small amounts. They work at normal temperature and pressure [less energy input to maintain].



Medicinal Applications of Biotechnology

Glucose Urine Test

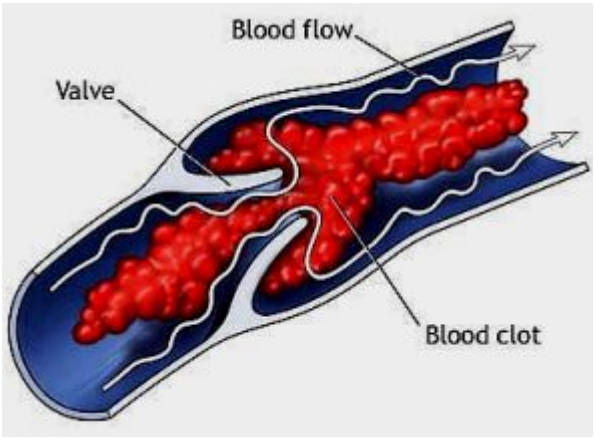
A common application of biotechnology in Medicine is the glucose urine test.

For this test, the enzymes glucose oxidase and glucose peroxidase is used to detect the amount of glucose in a urine sample.

Firstly, glucose oxidase enzyme reacts with glucose to give H2O2. After which, glucose peroxidase uses H2O2 to change the colour of the patch [urine sample]. The intensity [colour] of the patch indicates the amount of glucose present in the urine sample.

Patients with high glucose content in their urine sample most likely are diagnosed with diabetes.

Thrombosis



Thrombosis is the formation of a blood clot inside a blood vessel that obstructs blood flow in the circulatory system. Problems can arise when these blood clots form in vital areas such as the brain, heart, etc.

In this case, Plasmin can be used to mediate the blood clot. Plasmin is an important enzyme in the body that degrades many blood plasma proteins, most notably, fibrin clots. Hence, Plasmin can be used to “digest” away the blood clot.

Note: There are many other enzymes that can play a part in mediating thrombosis. Plasmin is a notable enzyme though.

This example of thrombosis demonstrates the fact the biotechnology can be life-saving.

Household Products

House hold products include biological washing powders, which contain protease, amylase and lipase. It removes stains, like blood [proteins], starch [carbohydrates], grease [fats].

It was first invented in 1965, withdrawn because factory workers developed allergies. To solve this, the enzymes were recently encapsulated in inert coating. In the present, thermostable enzymes like Staphylothermus marinus [thermophillic bacteria] is used.

The differences between biological and regular washing powders

	Biological washing powder	Regular washing powder
Detergents Mix greasy dirt with H_2O so it can be washed away	(+)	(+)
Enzymes **Braking** down stains and dirt in fabrics	(+) **Proteases** → proteins (blood, egg, gravy*...) **Amylases** → starches **Lipases** → fats and grease **Cellulase** → micro fibrils on cotton, brightening color of washed clothes They work efficiently at 40°C.	(-)
Remove **difficult stains** (blood, gravy, egg yolk, sweat, fats and grease)	**Easily** by decomposing the stains.	**Difficultly**. **Heat** alone makes stains coagulate and attach more firmly to the clothing.

**Gravy: juices that drip from cooking meat.*

Industrial Uses of Enzymes

Industry	Application of Enzymes in Industry	Enzyme[s] Involved	Where Enzymes are Found At
Brewing Industry	Reduce wine/beer cloudiness; breakdown of starch to glucose for fermentation by yeast	Protease Amylase	Bacteria Germinating Barley
Food Industry	Produce fructose syrup from glucose Juice production Pre-digestion of some baby foods Meat Tenderisation	Glucose isomerase Cellulase, Hemicellulose Pectinase Trypsin Bromelain Papain Ficin	Bacteria Pineapple Papaya Fig

Dairy Industry	Cheese manufacture to coagulate milk proteins	rennin	Stomach of calves
Textile Industry	Remove starch from fibres	Amylase	Bacteria and Fungi
Forestry industry	Removal of lignin from pulverized wood, prior to use of wood cellulose in manufacturing processes Partial breakdown of starch to produce smooth 'quality' paper	Ligninases Amylase	Fungi Bacteria and fungi
Medical Industry	Removal of blood clots and in wound cleansing Used in biosensors	Trypsin Various Enzymes	Bacteria Bacteria

Immobilised Enzymes

Immobilised enzymes are are isolated enzymes that are attached to, or retained within, an insoluble support material. The reaction mixture on which the enzyme acts on is then passed through this support material.

Pros of Immobilised enzymes:

- Enzymes can be reused
- The product is enzyme free
- Especially important if the enzyme is costly to extract in the first place, or if the products may have degraded or destroyed by the processes needed to remove the enzyme from them.

Immobilised Whole-cell versus Immobilised Cell-Free Enzymes

Whole-cell enzymes:

Advantages:

- In cases when enzymes or difficult to extract from cells in active form
- Or where a sequence of reactions is being catalysed by a group of related enzymes within the cell

Disadvantages:

- Substantial portion of the substrate is converted into bacterial biomass

- Optimal conditions to produce the product may not be optimum conditions for growth of the cell as a whole

Cell Free Enzymes:
Most of enzymes used on industrial scale are secreted by microorganisms and naturally act on their substrate outside the cell.

Advantages:

- Relatively easy to obtain in bulk
- No “wasteful” side reactions since other enzymes are not present

Disadvantage:

- Some enzymes may be difficult or expensive to extract

Immobilised Enzymes versus Isolated Free Enzyme

Isolated free enzymes added to the reaction mixture with no attempt made to reclaim the enzyme at the end of the reaction e.g. enzymes in domestic detergents. Immobilised enzymes have much higher level of enzymatic activity compared to immobilised enzymes.

Production of Lactose-free Milk