What are Enzymes?

Enzymes are **proteins**. Like other proteins, enzymes consist of long chains of amino acids held together by peptide bonds. They are present in all living cells, where they perform a vital function by controlling the metabolic processes whereby nutrients are converted into energy and fresh cell material. Furthermore, enzymes take part in the breakdown of food materials into simpler compounds. Some of the best known enzymes are those found in the digestive tract where pepsin, trypsin and peptidases break down proteins into amino acids, lipases split fats into glycerol and fatty acids, and amylases break down starch into simple sugars.

Enzymes are **catalysts** Enzymes are capable of performing these tasks because, unlike food proteins such as case in egg albumin, gelatine or soya protein, they are catalysts. This means that by their mere presence, and without being consumed in the process, enzymes can speed up chemical processes that would otherwise run very slowly, if at all.;

Enzymes are **specific** Contrary to inorganic catalysts such as acids, bases, metals and metal oxides, enzymes are very specific. In other words, each enzyme can break down or synthesize one particular compound. In some cases, they limit their action to specific bonds in the compounds with which they react. Most proteases, for instance, can break down several types of protein, but in each protein molecule only certain bonds will be cleaved depending on which enzyme is used.

Enzymes are very efficient catalysts. For example, the enzyme catalase, which is found abundantly in the liver and in the red blood cells, is so efficient that in one minute one enzyme molecule can catalyze the breakdown of five million molecules of hydrogen peroxide to water and oxygen.

Enzymes are part of a sustainable environment. Enzymes are present in all biological systems. They come from natural systems and when they are degraded, the amino acids of which they are made can be readily absorbed back into nature.

Enzymes work only on renewable raw materials. Fruit, cereals, milk, fats, meat, cotton, leather and wood are some typical candidates for enzymatic conversion in industry. Both the usable products and the waste of most enzymatic reactions are non-toxic and readily broken down..

Enzymes are at work in our bodies; - Just eat something.
One enzyme is already at work in your mouth while you chew; Amylases break down starch into smaller sugars - dextrins and maltose. Typical starchy foods are potatoes, pasta and rice. When the food reaches your stomach, acidic gastric juices start to flow from special glands. An important component of these juices is

the enzyme pepsin. This is a protein splitting enzyme and it works best in the conditions of high acidity found in the stomach. The partly digested food and gastric juices are then churned around in your stomach and propelled into the duodenum. It is here that another important part of digestion takes place. Pancreatic juice is released from the pancreas and this neutralizes the acid. An enzyme contained in the juice chops starch into its simplest sugars, and another breaks the protein down further into amino acids, which are one of the main building blocks of all living matter. So far, any fat has remained untouched, but now an enzyme made in the pancreas, a lipase, digests the fat. About seven hours after you have eaten your food, it passes from the duodenum into the small intestine where most of the nutrients liberated by the enzymes are absorbed and pass into your blood. The work of the enzymes is over. They have performed a small miracle. They have helped to transform food into tiny nutrients that the body can absorb and use to renew aging cells and to provide energy. Each day muscles burn up several hundred grams of carbohydrate and fat for energy. Without enzymes, our bodies would cease to function.

Enzymes in nature

The biological carbon cycle in nature involves the uptake of carbon dioxide into plants, its fixation by photosynthesis, and the various ways in which it is returned to the atmosphere. Enzymes play an important role in all the biological processes of this cycle.

All our food, whether plant or animal, contains enzymes. All living organisms produce their own enzymes to provide the nutrients they need. Just as our bodies produce enzymes.

Why use Enzymes?

Enzymes can be used to replace harsh conditions and harsh chemicals, thus saving energy and preventing pollution. They are also highly specific, which means fewer unwanted side-effects and by-products in the production process.

Enzymes themselves are biodegradable, so they are readily absorbed back into nature.

How Enzymes Are Named

At first, enzymes were named with an ending of **-in**. These usually note pancreatic enzymes because these were identified first: trypsin, rennin (used in cheese making), pepsin, chymotrypsin, etc.

Then researchers went to a naming system where any enzyme was given the ending **-ase**. This is used for metabolic as well as digestive enzymes. When you see **-ase**, read it as 'an enzyme which acts on...whatever is the front part of the name.'

Sugars usually end in **-ose** (lactose, sucrose, fructose). Therefore, sucr**ase** is an enzyme, which acts on sucr**ose**. In this case, the action is to break it down.

Lact**ase** is an enzyme, which acts on lact**ose** - in this case, the action is to break lactose down.

One metabolic enzyme is pyruvate dehydrogen**ase**. This is an enzyme, which acts on pyruvate, and the action is to remove a hydrogen molecule. Just an example of an action that is not food breakdown. There are many other types of actions too. An enzyme reaction important with sulfur is phenol sulfotransfer**ase**. It involves the transfer of sulfur with a phenol compound.

All enzymes themselves are proteins that consist of amino acids just like all other proteins.

Enzymes That Work on Specific Food Types or Compounds

Specific enzymes work on specific foods. You need the right type of enzyme for the foods you want it to break down. Think of the foods you have problems with and then choose a product that contains at least those types of enzymes. Here is a list of the common enzyme types and foods they act on.

Digestive enzymes are enzymes that break down food into usable material. The major different types of digestive enzymes are:

- amylase – breaks down carbohydrates, starches, and sugars which are prevalent in potatoes, fruits, vegetables, and many snack foods
- lactase – breaks down lactose (milk sugars)
- diastase – digests vegetable starch
- sucrase – digests complex sugars and starches
- maltase – digests disaccharides to monosaccharides (malt sugars)
- invertase – breaks down sucrose (table sugar)
- glucoamylase – breaks down starch to glucose
- alpha-glactosidase – facilitates digestion of beans, legumes, seeds, roots, soy products, and underground stems
- protease – breaks down proteins found in meats, nuts, eggs, and cheese
- pepsin – breaks down proteins into peptides
- peptidase – breaks down small peptide proteins to amino acids
- trypsin – derived from animal pancreas, breaks down proteins
- alpha – chymotrypsin, an animal-derived enzyme, breaks down proteins
- bromelain – derived from pineapple, breaks down a broad spectrum of proteins, has anti-inflammatory properties, effective over very wide pH range
- papain – derived from raw papaya, broad range of substrates and pH, works well breaking down small and large proteins
- lipase – breaks down fats found in most dairy products, nuts, oils, and meat
- cellulase – breaks down cellulose, plant fiber; not found in humans

- betaine HCL – increases the hydrochloric acid content of the upper digestive system; activates the protein digesting enzyme pepsin in the stomach (does not influence plant- or fungal-derived enzymes)
- CereCalase™ – a unique cellulase complex from National Enzyme Company that maximizes fiber and cereal digestion and absorption of essential minerals; an exclusive blend of synergistic phytase, hemicellulase, and beta-glucanase
- endoprotease – cleaves peptide bonds from the interior of peptide chains
- exoprotease – cleaves off amino acids from the ends of peptide chain
- extract of ox bile – an animal-derived enzyme, stimulates the intestine to move
- fructooligosaccharides (FOS) – helps support the growth of friendly intestinal microbes, also inhibits the growth of harmful species
- L-glutamic acid – activates the protein digesting enzyme pepsin in the stomach
- lysozyme – an animal-derived enzyme, and a component of every lung cell; lysozyme is very important in the control of infections, attacks invading bacterial and viruses
- papayotin – from papaya
- pancreatin – an animal-derived enzyme, breaks down protein and fats
- pancrelipase – an animal-derived enzyme, breaks down protein, fats, and carbohydrates
- pectinase – breaks down the pectin in fruit

- phytase – digests phytic acid, allows minerals such as calcium, zinc, copper, manganese, etc. to be more available by the body, but does not break down any food proteins
- xylanase – breaks down xylan sugars, works well with grains such as corn

Other general terms for enzymes referring to their general action instead of specific action

- Endopeptidase: Enzymes that cleave proteins only on the inside
- Exopeptidase: Enzymes that cleave proteins only on the outside (terminal) part
  - Aminopeptidase: Exopeptidase that cleaves at the amino terminating end
  - Carboxypeptidase: Exopeptidase that cleaves at the carboxy terminating end

Abbreviations

AGU	Amyloglucosidase Units
ALU	Acid Lactase Unit
BG	Beta Gulcanase Unit
CFU	Colony Forming Unit
CU	Cellulase Units
FCC	Food Chemicals Codex
FDA	Food and Drug Administration
FIP	Federation Internationale Pharmaceutique

GDU	Gelatin Digestive Unit
HCU	HemiCellulase Unit
HUT	Hemoglobin Unit on the Tyrosine basis
LAPU	Leucine Amino Peptidase Unit
PC	Plant Proteolytic Unit
SAPU	Spectrophotometric Acid **Protease** Unit
SKB	Sandstedt, Kneen & Blish
SU	Sumner Units
USDA	United States Department of Agriculture
USP	United States Pharmacopeia
XU	Xylanase Unit