Enzymes and Vitamins

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Organic molecules with a protein structure tat can catalyze numerous biochemical reactions in the cell that are also synthesized in the cell are called **enzymes**. Enzymes initiate and terminate a reaction by acting like a chemical catalyzer . Since they have protein structure, all factors that change the structure of the protein also effects the enzyme.

Some enzymes are made up of pure protein molecules, these are called **simple enzymes**. Pepsin, trypsin and chymotrypsin are examples for them. Some other enzymes require inorganic metal ions called **cofactor** or complex organic molecules called **coenzyme** to exert their activities. These enzymes are called compound enzymes. Cofactors and coenzymes bind to the enzyme during the reaction temporarily and they are easily broken off. Some enzymes make bonds with covalent bonds and stay like that permanently.

Compound enzymes can not function without cofactors or coenzymes.

For example, cytochrome oxidase requires cofactor like **Cu^{+2}**; DNA polymerase requires **Zn^{+2}**; ürease requires **Ni^{+2}**. Amylase enzyme found in saliva needs **Cl^{-}** as the cofactor to break down starch. Cytochrome-c reductase can not be active without FMN; glucose oxidase without FAD; malic dehydrogenase without NAD^{+}. Some vitamins are also very important coenzymes.

Some enzymes and their cofactors

(inorganic elements)

Enzymes	Cofactors
Amilase	Cl^{-}
Arginase	Mn^{+2}
Hexokinase	Mg^{+2}
Cytochrome oxidase	Cu^{+2}
Catalase	Fe^{+2}, Fe^{+3}
Peroxidase	Fe^{+2}, Fe^{+3}
DNA polimerase	Zn^{+2}
Urease	Ni^{+2}
Glycose 6 phosphatase	Mg^{+2}

Some enzymes and their coenzymes

Enzymes	Coenzymes
Xanthine oxidase	FAD
Pyruvic decarboxylase	Thiamin (Vitamin B_1)
Cytochrome c reductase	FMN
Malic dehydrogenase	NAD^+
Acetyl CoA carboxylase	Biotin
Isocitric dehydrogenase	$NADP^+$
Glutamic oxaloacetic transaminase	Pyridoxal phosphate (Vitamin B_6)

In an enzymatic reaction, the substance entering the reaction is called **substrate**, the substance effecting the substrate is called **enzyme**. The efficacy of an enzyme is related to the substrate, if the amount of the substrate is not sufficient, then the abundance of the enzyme itself has no meaning. Enzymes are specific to substrate and catalyzes the substrate by choosing a certain reaction. For example, urease enzyme can only break urea into ammonium and carbon dioxide, it can not process another substance.

Enzymes work extremely fast compared to other catalyzer and carry out the reactions rapidly. Some enzymes effects millions of molecules per minute. Enzymes lower the activation energy compared to chemical catalyzers, therefore they need less energy and carry out the reactions at body temperature. On Chemical catalyzers on the other hand perform this very slowly and by spending too much energy.

Some enzymes are synthesized as **proenzymes**. They are ineffective in this form and are activated later on.

Some proenzymes and their active forms are as follows:

Proenzyme	**Where synthesized**	**Active enzyme**
Pepsinogen	Stomach	Pepsin
Trypsinogen	Pancreas	Trypsin
Chymotrypsinogen	Pancreas	Chymotrypsin
Proelastase	Pancreas	Elastase

Classification of Enzymes:

1) Oxidoreductases: Oxidation-reduction reactions, electron transfer
2) Transferases: Removes a functional molecule from a molecule and carried it to another acceptor
3) Hydrolases: Breaking some bonds by using water molecule (hydrolytic reaction)
4) Lyases: Hydrolyzes the bonds between C-C, C-O andC-N and breaking them in a different way than oxidation
5) Isomerases: Catalyzes geometric and structural changes within a molecule
6) Synthetases and Lygases: Bond formation between C-O, C-S, C-N, C-C (In general these enzymes hydrolyzes the pyrophosphate in the ATP or in other triphosphates and attaches two molecule to each other).

Vitamins:

These are organic substances that are necessary for cell metabolism and vital for growth, development and healthy living) even in small amounts. They are the **coenzymes** for many enzymes that catalyze the biochemical reactions in the cell. Therefore, certain reactions can not take place in certain vitamin insufficiencies.

The reasons for widespread vitamin and mineral deficiencies:

1) Food processing and storage leads to the loss of nutrients. And also during modern food processing sometimes salt, oil and food additives are added. For example, potato chips do not contain the fibers and vitamin C content that potatoes possess. However they are rich in sodium and oil. Most of the frozen vegetables lose nearly half of their vitamin B6 contents. If citrus fruits and other fruits are collected while still green or under bad conditions, they may lose most of their vitamin C contents.

2) Modern agricultural methods depletes the mineral and trace element content of the soil. Industrial pollution and acid rains also add up to this negative phenomenon. Most of the foods lose their trace element content due to the soil that they grow in. Of course it is possible to grow healthy plants in selenium and zinc depleted soil, however their mineral contents will be reduced absolutely.

3) Humans often make wrong decisions related to their diets. Typical diets in the industrialized World contains meat, refined cereals, whole milk products and processed foods. As a result, their sodium, fat and cholesterol levels are much higher than recommended. On the other hand, their fiber, essential fatty acids and micronutrient levels are low.

4) Pollution in the cities increase our requirement of micronutrients, thus we need more antioxidants. High vitamin E and C intake protects us against liver damage due to air pollution. Selenium and zinc dependent enzyme systems reduce the toxicity resulting from heavy metals and xenobiotics; and our digestive system requires vitamin C to be protected against carcinogens found in foodstuff.

5) Alcohol, tobacco, caffeine and drugs lower the bioavailability of micronutrients. More than 90% of geriatric population uses drugs on a daily basis and they lead to some side effects. For example, thiazide diuretics depletes the body stores of potassium and magnesium. Contraceptives destroy the folate and vitamin B6 metabolism and increase the requirement for these vitamins. Smoking too much cigarettes depletes the body stores of Vitamins C and B_{12} and alcohol consumption leads to the loss of iron, zinc, magnesium and vitamin B..

Vitamins are divided into two groups as water soluble vitamins and fat soluble vitamins:

- Water soluble vitamins: Vitamins B_1 (Thiamine), B_2 (Riboflavin), Niacin (Nicotinamide), B_6 (Pyridoxine), B_{12} (Cyanocobalamin), C (Ascorbic acid)

These vitamins can not be stored in the body and have to be taken at certain amounts every day.

2) Fat soluble vitamins: Vitamins A, D, E (Tocopherol), K

These vitamins require cholesterol for their synthesis and can be stored in fat tissues. They can be released from the fat tissue when the body needs them.