Module 15 / Enzyme Nomenclature

Explain the difference between a kinase and a phosphatase

Describe the reactions catalyzed by dehydrogenases, hydratases, isomerases, and synthetases.

There are thousands of different enzymes in any cell. Most enzymes bind a specific substrate, perform a simple chemical change on that substrate, and then release a product.

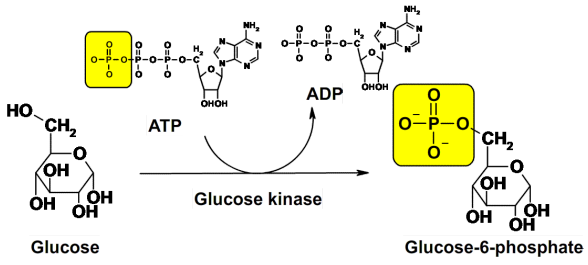
Each enzyme has a unique name. Usually, the name of an enzymes is systematic, but many exceptions exist. Almost all enzyme names have the suffix **ase**, indicating that they are an enzyme, for example kin**ase**, ly**ase**, phosphat**ase**, etc. Usually, but unfortunately not always, the name of the enzyme is derived from the nature of the chemical change that it catalyzes. For example, an enzyme that oxidizes its substrate is referred to as a dehydrogenase because it removes hydrogens atoms during the oxidation process.

To further clarify the name of the enzyme, the name of the substrate or product is often included in the name. For example, the enzyme that oxidizes succinate is called succinate dehydrogenase. Keep in mind that most reactions in pathways are reversible, so the name may describe the reverse reaction. Lastly, in cases when enzymes bind more than one substrate, the name can also suggest the co-substrate. For examples, dehydrogenases will use NAD^+ or FAD as co-substrates.

Important Classes of enzymes

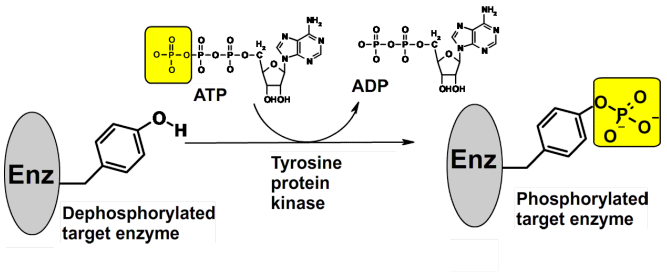
Although there is a large number of enzyme catalyzed reactions in a cell, the following list describes most of the activities that are found in metabolic pathways.

Kinase. A kinase transfers a phosphate group from ATP to the substrate. Kinases are used when direct coupling is required to reduce the Gibbs free energy of the reaction.



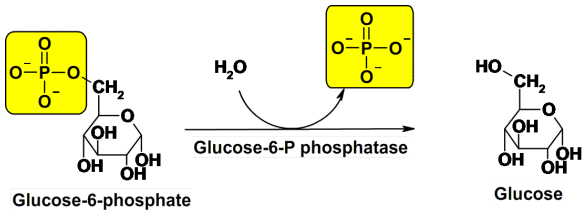
Phosphorylation of glucose by glucose kinase. Note that the source of phosphate is ATP, not inorganic phosphate.

Alternatively, a kinase may be involved in regulation of enzymes by transferring a phosphate from ATP to a Serine, Threonine, or Tyrosine on the enzyme that is being regulated. The phosphorylated form of the enzyme may be active or inactive.



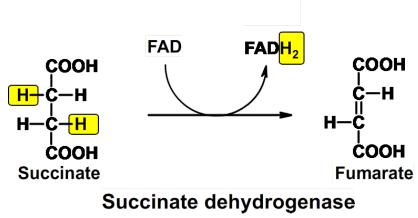
A protein kinase phosphorylates an enzyme, causing it to change its state from active to inactive or from inactive to active.

Phosphatase. A phosphatase removes a phosphate group by a hydrolysis reaction, producing inorganic phosphate. ADP or ATP are not involved in the reaction.



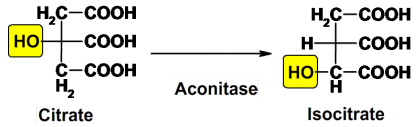
A phosphatase uses water to remove a phosphate group from its substrate. Phosphatases can act on small molecules, as shown above, or on phosphorylated proteins.

Dehydrogenase. As the name suggests, enzymes of this group transfer hydrogen atoms from the substrate to an electron acceptor, such as NAD^+ or FAD . Therefore they are redox enzymes since removal of hydrogen atoms is the equivalent to removal of electrons. The name is applied to both oxidation and reduction reactions.



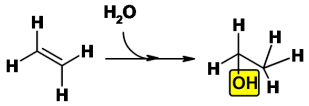
Succinate dehydrogenase, an example from the citric acid (TCA) cycle, is shown. FAD is the obligatory co-substrate, accepting electrons in this case. Note that this enzyme could also have been called fumarate dehydrogenase.

Isomerase. This class of enzymes rearrange functional groups on their substrates, releasing a product that has the same number of atoms as the substrate, but is an isomer of the original substrate. Unfortunately, the descriptive word "isomerase" is often omitted from their name.



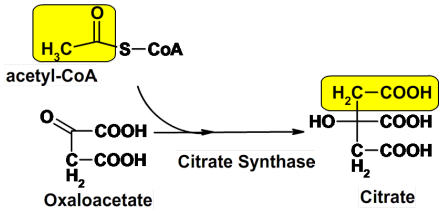
Aconitase is an isomerase that functions in the citric acid cycle to convert citrate to isocitrate. Note that the composition of both substrate and product are the same, but the chemical structure is not.

Hydratase. This reaction type, which has a number of idiosyncratic names in different pathways, adds water to a double bond.



The addition of water to a double bond to produce an alcohol.

Synthetase. These enzyme are responsible for the synthesis of more complex molecules from simpler substrates. For example, ATP synthase generates ATP from ADP and inorganic phosphate, a process that is driven by a proton gradient across a membrane. Citrate synthase catalyzes the following reaction, which is the first in the citric acid (TCA) cycle.



Citrate synthase combines acetyl-CoA and oxaloacetate to form citrate. The source of energy in this case is the high energy thio-ester in acetyl-CoA.

did I get this

The name of most enzymes consists of two words. The first word usually refers to the _____, while the second word refers to the _____ and has the suffix ____.

- substrate, reaction type, "ase".
- reaction type, substrate, "ase".
- product, reaction type, "ase"

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