Archaeal enzymes (April 2017)

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Besides the eukaryotes and the prokaryotes, the archaea represent the third domain of life. They are unicellular and similar to bacteria in shape and size, but their metabolism resembles eukaryotic behaviour in many aspects, notably the enzymes involved in archaeal DNA replication. Archaea are ubiquitous and have been found in practically all environments. Species living under extreme conditions such as hot, highly saline, alkaline or acidic waters, or under high pressure in the deep sea, were the first to be discovered. These "extremophiles" developed special strategies to maintain the stability of their cellular structure and to thrive despite limited nutrient supply, making for unique and interesting enzymes. In this short communication we will list of a few of the specialized enzymes found in archaea.

For surviving under harsh conditions the cellular structures must be highly stable. Archaeal membranes achieve that by containing archaetidylserine (2,3-bis-(*O*-phytanyl)-*sn*-glycero-1-phospho-L-serine), which is based on glycerol ether components instead of glycerol fatty acid esters. The enzymes involved in the biosynthesis of archaeal lipids have been newly classified and are shown in the diagram for archaetidylserine biosynthesis.

Polyamines are required to maintain the stability of double-stranded DNA. Where eukaryotes and prokaryotes produce linear spermine and spermidine, archaea synthesize branched-chain and long-chain polyamines, such as N^4-bis(aminopropyl)spermidine or caldopentamine, which confer a higher stability. The enzymes involved in their synthesis are classified as EC 2.5.1.127 and EC 2.5.1.128.

During their long evolution archaea developed strategies for taking up nutrients very efficiently. The substrate specificity of archaeal enzymes is often less strict than that of their bacterial counterparts. For example, two new enzymes of the archaeal Entner-Doudoroff pathway have been described, one being able to dehydrogenate either glucose or galactose (EC 1.1.1.360) and the other, with even less specificity, is able to dehydrogenate a broad range of aldoses (EC 1.1.1.359). In addition, archaea do not follow the classical route of the Entner-Doudoroff pathway, and instead use semi- or non-phosphorylative variants. Three enzymes that participate in these pathways have been newly classified: EC 1.2.1.89, EC 1.2.99.8 and EC 4.1.2.55.