Transformation Encyclopedia Article

Transformation

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Transformation is a process in which exogenous **DNA** is taken up by a (recipient) cell, sphaeroplast, or protoplast. In order to take up DNA, the cells must be competent. Competence is a state of bacterial cells during which the usually rigid cell wall can transport a relatively large DNA macromolecule. This is a highly unusual process, for **bacteria** normally lack the ability to transport macromolecules across the rigid cell wall and through the cyotplasmic membrane. Several bacteria, such as *Bacillus, Haemophilis, Neisseria,* and *Streptococcus,* possess natural competence because their cells do not require special treatment to take up DNA. This process is transient and occurs only in special growth phases, typically toward the end of log phase.

The demonstration of DNA transformation was a landmark in the history of genetics. In 1944, Oswald Avery, Colin MacLeod, and **Maclyn McCarty** conducted famous *Streptococcus pneumoniae* transformation experiments. Bacterial **pneumonia** is caused by the S strain of *S. pneumoniae.* The S strain synthesizes a slimy capsule around each cell. The capsule is composed of a polysaccharide that protects the bacterium from the immune response of the infected animal and enables the bacterium to cause the disease. The colonies of the S strain appear smooth because of the capsule formation. The strain that does not synthesize the polysaccharide, hence does not have the capsule, is called R strain because the surface of the colonies looks rough. The R strain does not cause the disease. When heat-killed S strain was mixed with live R strain, cultured, and spread on to a solid medium, a few S strain colonies appeared. When S cell extract was treated with RNase or proteinase and mixed with the live R strain, R colonies and a few S colonies appeared. When the S strain cell extract was treated with DNase and mixed with live R strain, there were only R strain colonies growing on the **agar** plates. These experiments proved fundamentally that DNA is the genetic material that carries genes.

Transformation is widely used in DNA manipulation in **molecular biology**. For most bacteria that do not possess natural competency, special treatment, such as calcium chloride treatment, can render the cells competent. This is one of the most important techniques for introducing recombinant DNA molecules into bacteria and **yeast** cells in genetic engineering.