Coordinate Genetic Regulation Encyclopedia Article

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Coordinate Genetic Regulation

The development of an organism—from a fertilized egg, through embryonic and juvenile stages, to adulthood in **eukaryotes**, and through the growth and division cycles and response to environmental stress in prokaryotes--requires the coordinated expression of sets of genes at the proper times and in the proper places. This coordination is directed by the expression of proteins encoded by genes termed master genes.

Studies in the fruit fly *Drosophila melanogaster* have provided keys to understanding the molecular basis of large-scale developmental activities. Early embryonic genes express proteins that set up the organism's anatomical orientation and segments. Later in time, homeotic genes direct the development of the segments into their distinct body parts.

Analogous genes are present in vertebrates as well. Sequence analysis has shown that the homeotic genes from *Drosophila* and vertebrates share a stretch of **deoxyribonucleic acid**, which is called a **homeobox**. The expressed proteins, homeobox proteins, share structural similarities with regions of regulatory proteins that bind to **DNA** promoters and enhancers. Thus, a homeobox protein elicits the coordinated expression of a number of genes when the protein binds to a specific promoter or enhancer region of the genes.

Bacteria have also developed means of coordinating the expression of multiple genes. This is essential for bacterial survival, since it would be energetically costly to produce all its proteins all the time. Selective and coordinated protein expression allows rapid adaptation to changing environmental conditions and **cell** situations, such as division.

In large part, these adaptations involve changes in **gene expression**, mediated by DNA-binding proteins and corresponding signaling systems. A single regulatory factor that coordinates the expression of numerous genes, thus affecting many phenotypic properties of the cell, is termed a global regulatory factor. An example of such a factor is the CsrA protein of *Escherichia coli*. By binding to specific messenger ribonucleic acids, CsrA can either stabilize the particular **mRNA** or cause its destruction.

A now classic example of coordinate regulation of metabolic activity in bacteria is the **operon**. Various operons exist, such as those for the production of tryptophan and the utilization of lactose. In these, **gene** expression is regulated at the level of **transcription**. Genes with related function are generally located adjacent to each other (the operon), facilitating their coordinate regulation (i.e., when one is expressed they are all expressed). Various gene products, whose binding can be positive, stimulating transcription, or negative, blocking transcription, achieve the genetic regulation in an operon.