The *lac* operon of *E. coli*

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All the genes in a living cell are not transcribed at any given time. It would be economical for the cell if specific genes were transcribed only when their gene products were needed. Some mechanism could exist that mediates the transcription of a gene to produce an mRNA that is translated to give the specific enzyme only when it is needed. One such mechanism of regulation of gene expression is well known in prokaryotes and can be easily studied in the laboratory with the ubiquitous *Escherichia coli*.

The *lacZ* gene in *E.coli* specifies the synthesis of β-galactosidase, one of three enzymes involved in the utilization of lactose. If lactose is not available in the medium, the genes for metabolizing the sugar are not expressed. However, if lactose is present in the medium, the genes for metabolizing this sugar are expressed and the bacterium is able to use lactose as an energy source. This phenomenon, where gene activity leads to the production of an enzyme in response to the presence of a substrate, is called induction.

The "repression" and "induction" of the *lacZ* gene of *E. coli* can be demonstrated *in vivo* using a simple color assay. The enzyme β-galactosidase hydrolyzes ONPG (ortho-nitrophenyl-β-D-galactoside), a colorless derivative of lactose, into two products, galactose and the ortho-nitrophenolate ion which has a yellow color. By adding this colorless substrate to bacterial cultures and examining them for the yellow coloration, one can determine the regulation of the *lacZ* gene in four different strains of *E. coli.*

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