There are two basic modes by which bacteria regulate gene expression:

Positive control (ex. lactose catabolism)
Under positive control, the presence of a regulatory molecule enhances the activity of RNA polymerase

Negative control
Under negative control, the presence of a regulatory molecule impedes the activity of RNA polymerase

Negative control is further subdivided into two mechanisms:

Inducible (ex. lactose catabolism)
The catabolic substrate renders the repressor inactive—lactose acts as an inducer

Repressible (ex. tryptophan synthesis)
The anabolic product activates the repressor – tryptophan acts as a corepressor

First, think of this from the point of view of the bacterial cell. Tryptophan is an essential amino acid needed as a building block for protein synthesis. There are two ways to get it: absorb it as a nutrient from the surroundings or make it your self. Making it yourself will require expenditure of raw materials and energy. If tryptophan is available to you as a nutrient, do you want to express the genes for enzymes that you need to make the amino acid? NO!! That would be like going to the golden arches the same night your mom makes your favorite dinner. What a waste!

Control of lactose catabolism is also logical. It just takes more factors into account. Lactose is a carbohydrate that can be broken down and used as fuel to make ATP. However, it is not as energy rich as glucose. So, if you are a bacterial cell and there is both glucose and lactose available as nutrients, will you express the genes to break down lactose? NO!! That's like buying a hamburger for the price of a quarter pounder. Forget it. Buy the quarter pounder. But if you only have a dollar in your pocket, buy the hamburger. In other words, if there's no glucose available, but there's lactose in the environment, express the genes to break down lactose.

The operon model
An *operon* is a cluster of genes with related functions and their corresponding regulatory sequences. Structural genes code for proteins involved in the same biological process. The structural genes are immediately preceded by an *operator* and a *promoter*. At a more distant site in the genome, a regulatory gene may code for a *repressor* protein. This repressor can bind to the operator and block the progress of RNA polymerase

In the case of inducible negative control, structural genes may be expressed only if the inducer is present. In the case of repressible negative control, structural genes may be expressed only if the corepressor is absent.

To explain the positive control mechanism of the lactose operon, you must first understand how the bacterial cell monitors glucose availability. When glucose is available, concentrations of cAMP inside the cell are low. When glucose is not available, concentrations of cAMP inside the cell are high. The cAMP molecule binds with another molecule called CRP. This duo enables RNA polymerase to transcribe the structural genes of the lactose operon with optimal efficiency. Without this positive control, RNA polymerase just slugs along, even if the repressor is not bound to the operator.