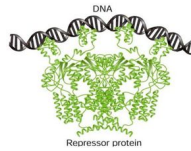


Gene regulation in bacteria

Today's Topics:

- **Transcriptional control**
 - Cells adjust to their environment by turning genes on and off
- **The operon concept**
 - Operators, Promoters, Repressors, Activators
- **Repressible operons** (e.g. *trp*)
- **Inducible operons** (e.g. *lac*)



16 Nov 2012

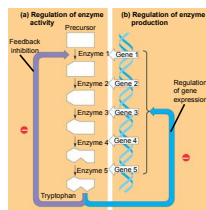
E.coli bacteria eat whatever we eat!

But ALL organisms must adjust to changes in their environment.



Regulation of metabolism occurs at two levels:

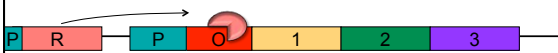
- Adjusting the activity of metabolic enzymes already present
 - How?
- Regulating the genes encoding the metabolic enzymes
 - How?



Types of Regulated Genes

- **Constitutive genes** are always expressed
 - Tend to be vital for basic cell functions (often called "housekeeping genes")
- **Inducible genes** are normally off, but can be turned on when substrate is present
 - Common for **catabolic** enzymes (i.e. for the utilization of particular resources)
- **Repressible genes** are normally on, but can be turned off when the end product is abundant
 - Common for **anabolic** enzymes

In bacteria, related genes are often clustered into Operons

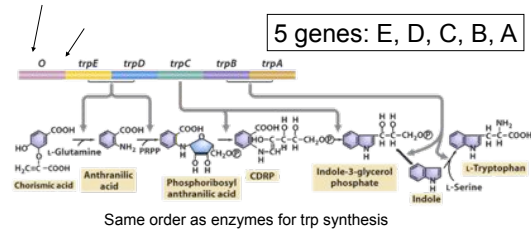


Operons have:

1. Several genes for metabolic enzymes
2. One promoter
3. An **operator**, or control site ("on-off" switch)
4. A separate gene that makes a **repressor** or **activator protein** that binds to the operator

The *trp* Operon

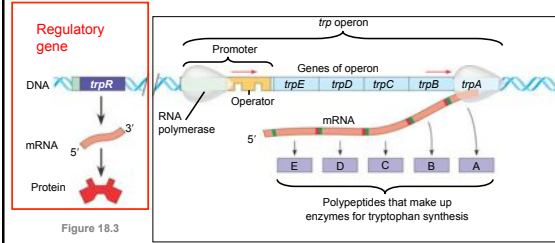
Controlled by a single promoter and operator



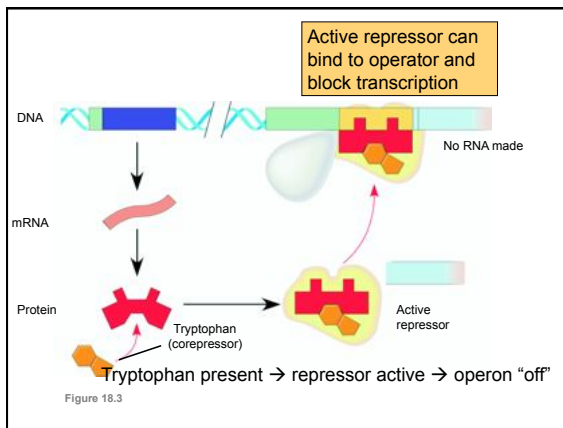
Terminology

- **Promoters** and **Operators** are **DNA sequences** upstream of genes
- **Repressors** and **Activators** are **proteins** that bind to DNA and control transcription.
- Co-repressors and Inducers are small "effector" molecules that bind to repressors or activators

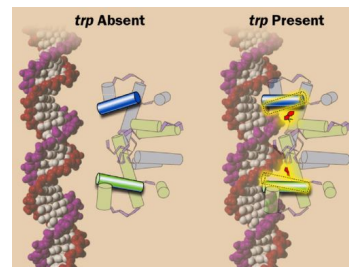
The *trp* operon: regulated synthesis of repressible enzymes



Tryptophan absent → repressor inactive → operon "on"

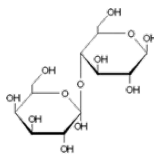


Tryptophan changes the shape of the repressor protein so it can bind DNA



The *lac* operon

- Lactose



- The *lac* operon: regulated synthesis of inducible enzymes

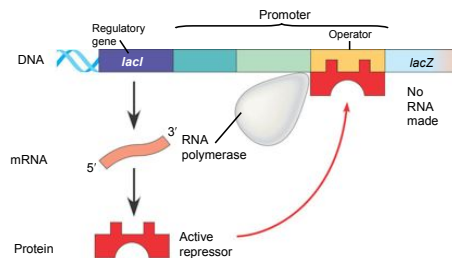
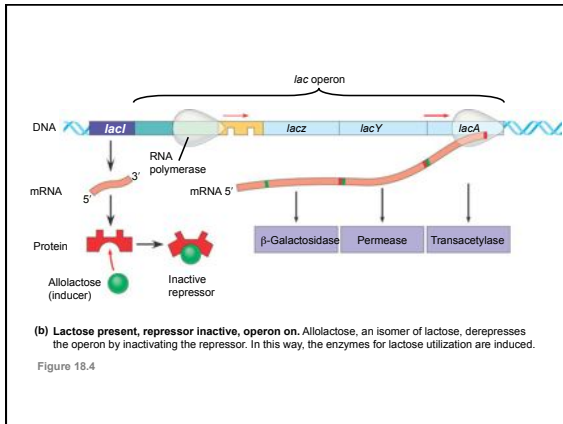


Figure 18.4



Positive vs Negative Gene Regulation

- Both the *trp* and *lac* operons involve negative control of genes
 - because the operons are switched off by the active form of the repressor protein
- Some operons are also subject to positive control
 - An **activator protein** is required to start transcription.
 - E.g. **catabolite activator protein (CAP)**

