

Bacterial Genetics

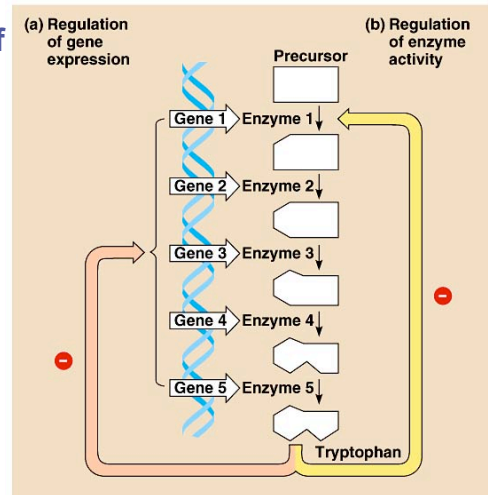
Regulation of Gene Expression

Regulation of metabolism

- **Feedback inhibition**
 - ◆ product acts as an allosteric inhibitor of 1st enzyme in tryptophan pathway
- **Gene regulation**
 - ◆ block transcription of genes for all enzymes in tryptophan pathway

AP Biology

⊖ = inhibition



Gene regulation in bacteria

- control of gene expression enables individual bacteria to adjust their metabolism to environmental change
- cells vary amount of specific enzymes by regulating gene transcription
 - ◆ turn gene on or turn gene off
 - **ex.** if you have enough tryptophan in your cell then you don't need to make enzymes used to build tryptophan
 - ◆ waste of energy
 - ◆ turn off gene which codes for enzyme

AP Biology

2004-2005

An individual bacterium, locked into the genome that it has inherited, can cope with environmental fluctuations by exerting metabolic control.

First, cells vary the number of specific enzyme molecules by regulating gene expression.

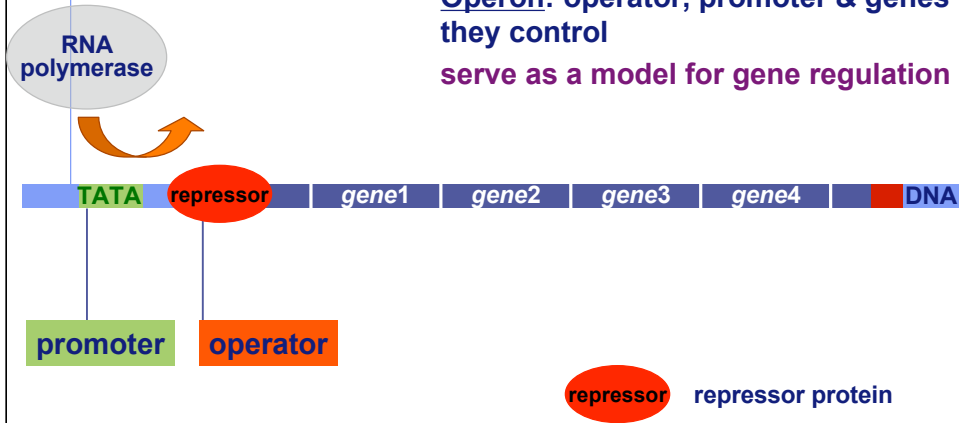
Second, cells adjust the activity of enzymes already present (for example, by feedback inhibition).

Repressor protein

- So how do you turn off genes?
 - ◆ repressor protein binds to DNA near promoter region (TATA box) blocking RNA polymerase
 - binds to **operator** site on DNA
 - blocks transcription

Repressor protein

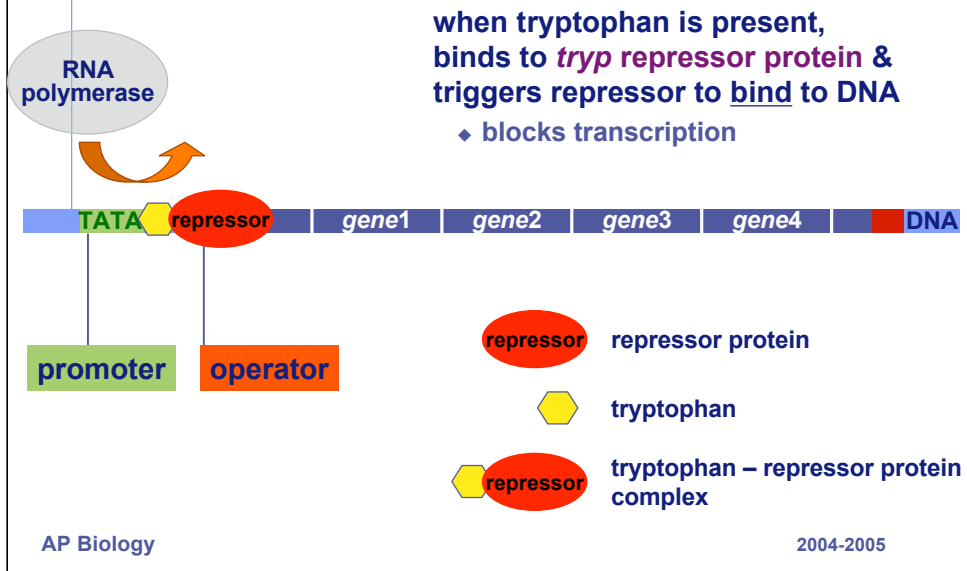
Operon: operator, promoter & genes they control
serve as a model for gene regulation



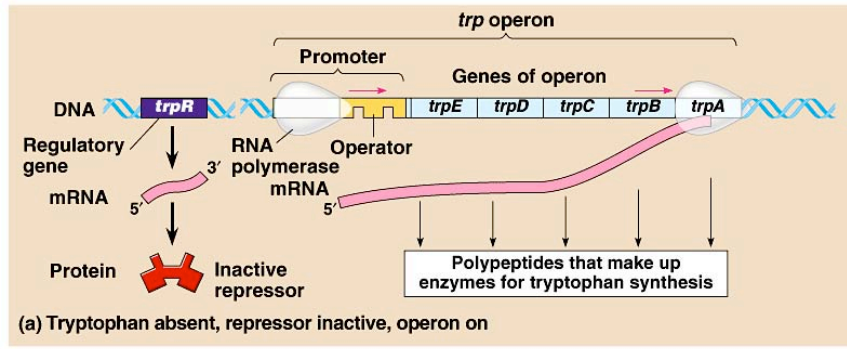
Operons

- **Bacteria often group together genes with related functions**
 - ◆ **ex.** enzymes in a biosynthesis pathway
- **Transcription of these genes is controlled by a single promoter**
 - ◆ when transcribed, read as 1 unit & a single mRNA is made
- **Operon**
 - ◆ operator, promoter & genes they control

Repressible operon: tryptophan

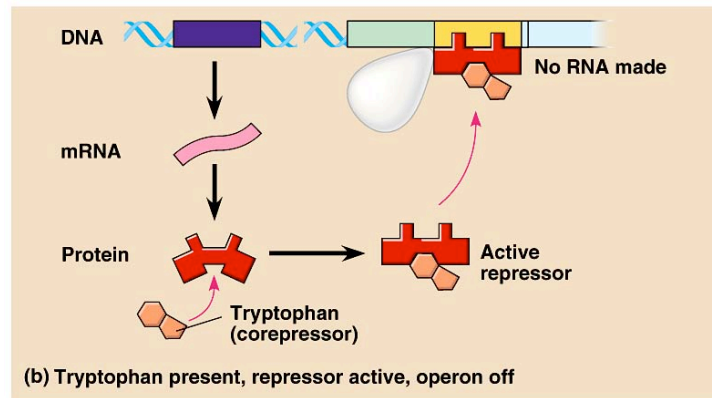


Tryptophan operon



Tryptophan operon

What happens when tryptophan is present?
Don't need to make tryptophan-building enzymes

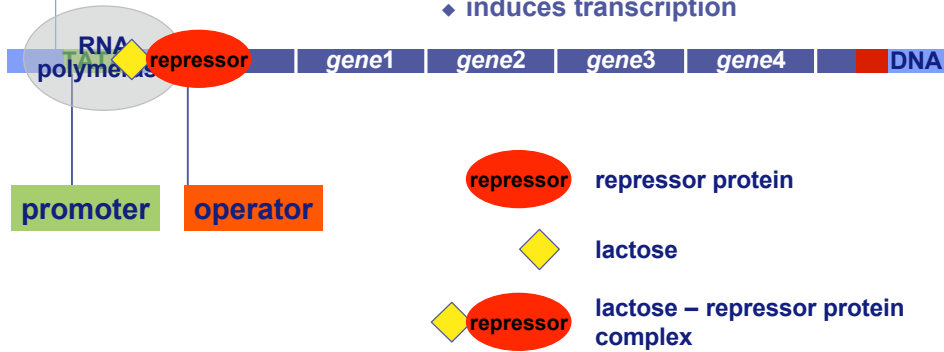


AP Bio Tryptophan binds allosterically to regulatory protein :005

Inducible operon: lactose

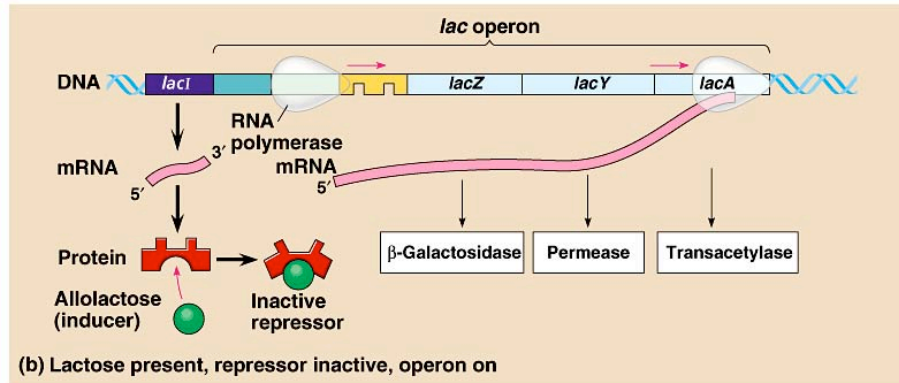
when lactose is present, binds to *lac* repressor protein & triggers repressor to release DNA

◆ induces transcription



Lactose operon

What happens when lactose is present?
Need to make lactose-digesting enzymes

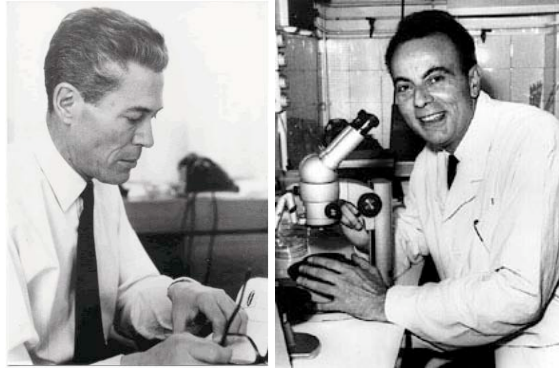


Lactose binds allosterically to regulatory protein

1961|1965

Jacob & Monod: *lac* Operon

- Francois Jacob & Jacques Monod
 - ◆ first to describe operon system
 - ◆ coined the phrase “operon”



AP Biology

Jacques Monod

Francois Jacob

Operon summary

- **Repressible operon**
 - ◆ usually functions in anabolic pathways
 - synthesizing end products
 - ◆ when end product is present cell allocates resources to other uses
- **Inducible operon**
 - ◆ usually functions in catabolic pathways,
 - digesting nutrients to simpler molecules
 - ◆ produce enzymes only when nutrient is available
 - cell avoids making proteins that have nothing to do