OPERONS

* Bacteria do not require the same enzymes all the time
* Enzymes are produced as needed
* François Jacob and Jacques Monod (1961) proposed the **operon** model to explain regulation of gene expression in prokaryotes
	+ An operon is a group of structural and regulatory genes that function as a single unit
* An operon consists of three components:
	+ **Promoter**
		- DNA sequence where RNA polymerase first attaches
		- Short segment of DNA
	+ **Operator**
		- DNA sequence where active repressor binds
		- Short segment of DNA
	+ **Structural Genes**
		- One to several genes coding for enzymes of a metabolic pathway
		- Transcribed simultaneously as a block
		- Long segment of DNA
	+ A **regulatory gene** that codes for a repressor protein
		- The regulatory gene is normally located outside the operon
		- The repressor protein controls whether the operon is active or not
* The *trp* Operon
	+ The regulator codes for a repressor
	+ If tryptophan (an amino acid) is absent:
		- Repressor is unable to attach to the operator (expression is normally “on”)
		- RNA polymerase binds to the promoter
		- Enzymes for synthesis of tryptophan are produced
	+ If tryptophan is present:
		- It combines with the repressor protein as its corepressor
		- Repressor becomes functional when bound to tryptophan
		- Repressor blocks synthesis of enzymes in the pathway for tryptophan synthesis
* The *lac* Operon
	+ The regulator codes for a repressor
	+ If lactose (a sugar that can be used for food) is absent:
		- The repressor attaches to the operator
		- Expression is normally “off”
	+ If lactose is present:
		- It combines with the repressor and renders it unable to bind to operator
		- RNA polymerase binds to the promoter
		- The three enzymes necessary for lactose catabolism are produced
* Further control of the *lac* operon
	+ *E. coli* preferentially breaks down glucose
	+ The *lac* operon is maximally activated only in the absence of glucose
	+ When glucose is absent
		- Cyclic AMP (cAMP) accumulates
		- cAMP binds to catabolite activator protein (CAP)
		- CAP, when bound to cAMP, binds to a site near the *lac* promoter
		- When CAP is bound, RNA polymerase binds better to the promoter
		- The structural genes of the *lac* operon as expressed more efficiently
* Further control of the *lac* operon
	+ When glucose is present
		- There is little cAMP in the cell
		- CAP is inactive
		- The *lac* operon is not expressed maximally