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