Operons: The Basic Concept

Structural gene = Gene that codes for a polypeptide.

Operon = A regulated cluster of adjacent structural genes with related functions.

- Has a single promoter region, so an RNA polymerase will transcribe all structural genes on an all-or-none basis.
- Transcription produces a single *polycistronic* mRNA with coding sequences for all enzymes in a metabolic pathway.

Polycistronic mRNA = A large mRNA molecule that is a transcript of several genes.

- Contains stop and start codons for the translation of each polypeptide.

Operator = A DNA segment between an operon's promoter and structural genes, which controls access of RNA polymerase to structural genes.

- Acts as an on/off switch for movement of RNA polymerase and transcription of the operon's structural genes.

Repressor = Specific protein that binds to an operator and blocks transcription of the operon.

- Blocks attachment of RNA polymerase to the promoter.
- Repressors are encoded by *regulatory genes*.

Regulatory genes = Genes that code for repressor or regulators of other genes.

- Are often located some distance away from the operons they control.
- Are involved in switching on or off the transcription of structural genes.

Corepressor = A molecule, usually a metabolite, that binds to a repressor protein, causing the repressor to change into its active conformation.

- Only the repressor-corepressor complex can attach to the operator and turn off the operon.

Repressible Versus Inducible Enzymes: Two Types of Negative Control

Repressible enzymes = Enzymes which have their synthesis inhibited by a metabolite (e.g., tryptophan).

Inducible enzymes = Enzymes which have their synthesis stimulated or induced by specific metabolites (e.g., *lac* operon).

Repressible Enzymes	Inducible Enzymes
● Their genes are switched on until a specific metabolite activates the repressor.	● Their genes are switched off until a specific metabolite inactivates the repressor.
● Generally function in anabolic pathways.	● Function in catabolic pathways.
● Pathway end product switches off its own production by repressing enzyme synthesis.	● Enzyme synthesis is switched on by the nutrient the pathway uses.

Positive control of a regulatory system occurs only if an activator molecule interacts directly with the genome to turn on transcription.

CAP (cAMP activator protein) = A protein that binds within an operon's promoter region and enhances the promoter's affinity for RNA polymerase.

- When glucose is missing, the cell accumulates cyclic AMP (**cAMP**), a nucleotide derived from ATP. cAMP activates CAP so that it can bind to the *lac* promoter.
- When glucose concentration rises, glucose catabolism decreases the intracellular concentration of cAMP.

Catabolite repression = Repression of a variety of unrelated catabolic enzymes when cells are grown in a medium containing glucose.

Enhancer/Silencer = Regulatory regions on eukaryotic DNA that bind activator/repressor proteins controlling single gene expression.