A variety of intercellular and intracellular signal transmissions mediate gene expression. (3.B.2)

- **A G Protein-coupled receptor** is a plasma membrane receptor that works with the help of a G protein, a protein that binds the energy rich **GTP** (guanosine triphosphate).

- **Cyclic AMP** the second messenger in a G-protein-signaling pathway.
  - The first messenger activates a G protein-coupled receptor, which activates a specific G protein. In turn, the G protein activates adenylyl cyclase, which catalyses the conversion of ATP to cAMP.
  - The cAMP acts as a second messenger and activates another protein, usually **protein kinase A** leading to cellular responses.

- **Levels of cAMP** regulate metabolic gene expression in **bacteria**.

- cAMP levels influence the positive control mechanism of gene regulation for the lac operon by CAP (Lecture 3B1).

- **CAP** and cAMP are involved in the coordination regulation of many **operons**, primarily those that encode enzymes for the metabolism of other secondary sugars such as galactose and arabinose.

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- **Cytoplasmic Determinants** and **Inductive Signals**
  - (a) Cytoplasmic determinants in the egg. The unfertilized egg has molecules, including the lac repressor. When glucose is present, lac repressor is synthesized, which results in the repression of the lac operon.
  - (b) Induction by nearby cells. The cells at the bottom of the early embryo depicted here are releasing chemicals that signal nearby cells to change their gene expression.
A variety of intercellular and intracellular signal transmissions mediate gene expression. (3.B.2)

- **Sequential regulation of gene expression during cellular differentiation of a muscle cell.**

  ![Diagram of muscle cell differentiation](image)

  **Determination.** Signals from other cells lead to activation of a master regulatory gene called myoD, and the cell makes Myo D protein, as a specific transcription factor that acts as an activator. The cell, now called a myoblast, is irreversibly committed to becoming a skeletal muscle cell.

  **Differentiation.** MyoD protein stimulates the myoD gene further and activates genes encoding other muscle-specific transcription factors, which in turn activate genes for muscle proteins. MyoD also turns on genes that block the cell cycle, thus stopping cell division. The non-dividing myoblasts fuse to become mature multinucleate muscle cells, also called muscle fibers.