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Problem 1A: Equations Explanation

Say that you have a gene *P* which produces a protein p. The starting material balance equations for the (1) mRNA made from gene *P* and then (2) translated to make protein p are:

$$(1)\ \dot{m} = r_X u - (\mu + \theta_m)m + \lambda$$

$$(2)\ \dot{p} = r_L w - (\mu + \theta_p)p$$

Where $\dot{m}$ and $\dot{p}$ are the rate of concentration change in mRNA and protein, respectively, and r_X and r_L are the regulated specific rates of transcription and translation. The u and w terms describe the control logic of the cell for transcription and translation. The terms θ_m and θ_p govern the rate of lumped non-specific degradation mechanisms for transcription and translation, and the λ term is the unregulated rate of transcription.

Of particular concern in this case is the dilution rate, μ, that is due to cell growth. We are considering a cell-free system that is contained in an abstract volume B. Therefore the dilution term is zero. The resulting material balance equations are:

$$(3)\ \dot{m} = r_X u - \theta_m m + \lambda$$

$$(4)\ \dot{p} = r_L w - \theta_p p$$