Problem Set 2. → CHEME 5440.

1a) Consider gene G (units: nmol/gDW) which produces protein p. The specific material balance equations governing the concentration of mRNA m (units: nmol/gDW) transcribed from gene G, which is then translated to produce protein p (units: nmol/gDW) is given by:-

$$\dot{m} = r_x u - (\mu + \sigma_m) m + \lambda \quad \text{—— (1)}$$

$$\dot{p} = r_L w - (\mu + \sigma_p) p \quad \text{—— (2)}$$

→ The terms in parenthesis; $(\mu+\sigma_m)$ & $(\mu+\sigma_p)$ denote the dilution and degredation terms.

→ 'μ' represents the specific growth rate of cells. However, as we are dealing with a cell-free system (there are no cells present), 'μ' reduces to 0.

∴ The eqns. now reduce to:-

$$\dot{m} = r_x u - \sigma_m m + \lambda$$

$$\dot{p} = r_L w - \sigma_p p$$

where the term $r_x u$ (units: nmol/gDW-hr) denotes the regulated specific rate of transcription of the gene (production rate of mRNA), while $r_L w$ (units: nmol/gDW-hr) denotes the specific rate of translation of message (production rate of protein). The term 'λ' denotes the unregulated rate of transcription (the leak for gene G).