i **always refers to different species**
α **and** β **to resources**

external supply

dilution rates

consumption rate of a by i, per unit concentrations of both

determines the byproducts created when i consumes β

total leakage of β when consumed by i

resource concentrations
$$\frac{\partial R_\alpha}{\partial t} = \underbrace{K_\alpha - r_\alpha R_\alpha}_{\textit{chemostat terms}} - \sum_i \underbrace{N_i c_{i\alpha} R_\alpha}_{\textit{total consumption of a by i}} + \sum_{i,\beta} \frac{w_\beta}{w_\alpha} D_{i\alpha\beta}\, l_{i\beta} \underline{N_i c_{i\beta} R_\beta} + D_{R_\alpha} \nabla^2 R_\alpha$$

unit conversion factors

diffusion constants

species concentrations
$$\frac{\partial N_i}{\partial t} = g_i N_i \left(\sum_\alpha (1 - l_{i\alpha}) w_\alpha c_{i\alpha} R_\alpha - m_i \right) + D_{N_i} \nabla^2 N_i$$

cell upkeep energy consumptionl

Energetic model

- N_i **and** R_α **are treated as forms of energy**
- g_i and w_α facilitate conversion to biomass
- K_α are the energy sources and r_α and m_i are the energy sinks
- everything else is an energy conversion

Consumption with leakage and byproducts