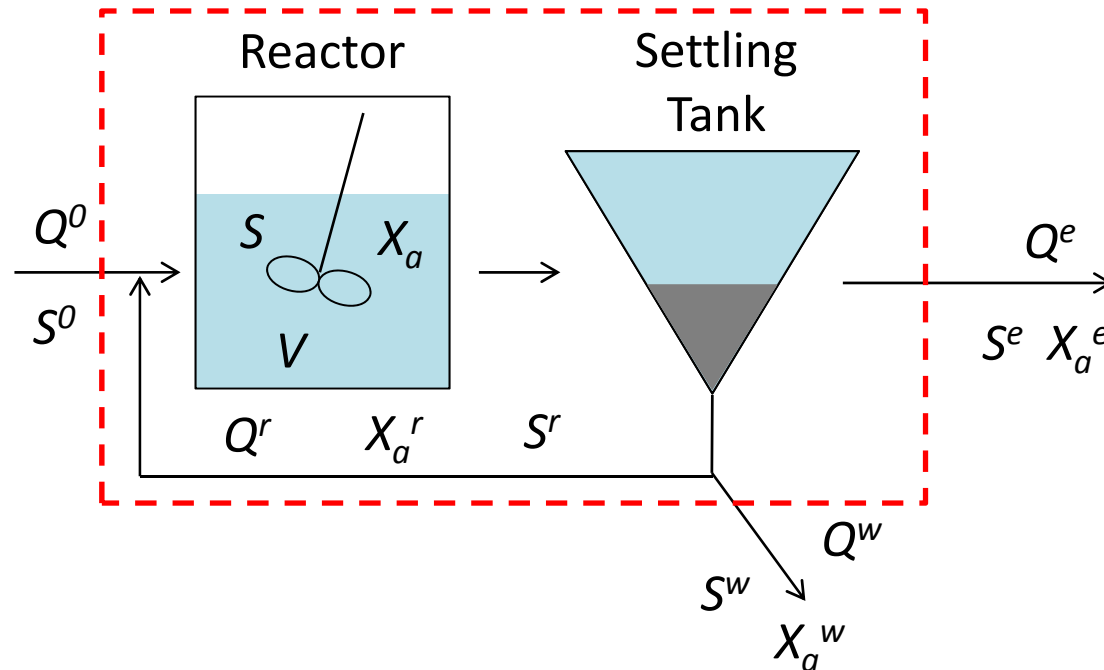# Microbial kinetics in reactors III

Today's lecture

- Further on example questions
- CSTR with settling and cell recycling

CSTR with settling and cell recycling

From flow mass balance:
$Q^0 = Q^e + Q^w$

Assumptions
- Biodegradation of soluble substrates in the reactor only, no biodegradation in the settling tank ($S = S^e = S^w = S^r$)
- No active biomass in influent
- Steady state

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CSTR with settling and cell recycling

- Active biomass mass balance:

$$0 = 0 - (Q^e X_a{}^e + Q^w X_a{}^w) + r_{net}V$$

- Substrate mass balance:

$$0 = Q^0 S^0 - (Q^e S + Q^w S) + r_{ut}V$$

CSTR with settling and cell recycling

- Two solve the mass balance equations, use the following relationships:

$$\theta_x = \frac{active\ biomass\ in\ the\ system}{production\ rate\ of\ active\ biomass} = \frac{X_a V}{Q^e X_a^{\,e} + Q^w X_a^{\,w}}$$

$$r_{ut} = \frac{rate\ of\ mass\ substrate\ utilized}{volume\ of\ reactor} = \frac{Q^0 S^0 - Q^e S - Q^w S}{V}$$

$$= \frac{Q^0(S^0 - S)}{V} = \frac{S^0 - S}{\theta}$$

CSTR with settling and cell recycling

- Solutions:

$$S = K \frac{1 + b\theta_x}{\theta_x(Y\hat{q} - b) - 1}$$

$$X_a = \frac{\theta_x}{\theta} \frac{Y(S^0 - S)}{1 + b\theta_x}$$

→ Compare with our solutions for CSTR without cell recycling