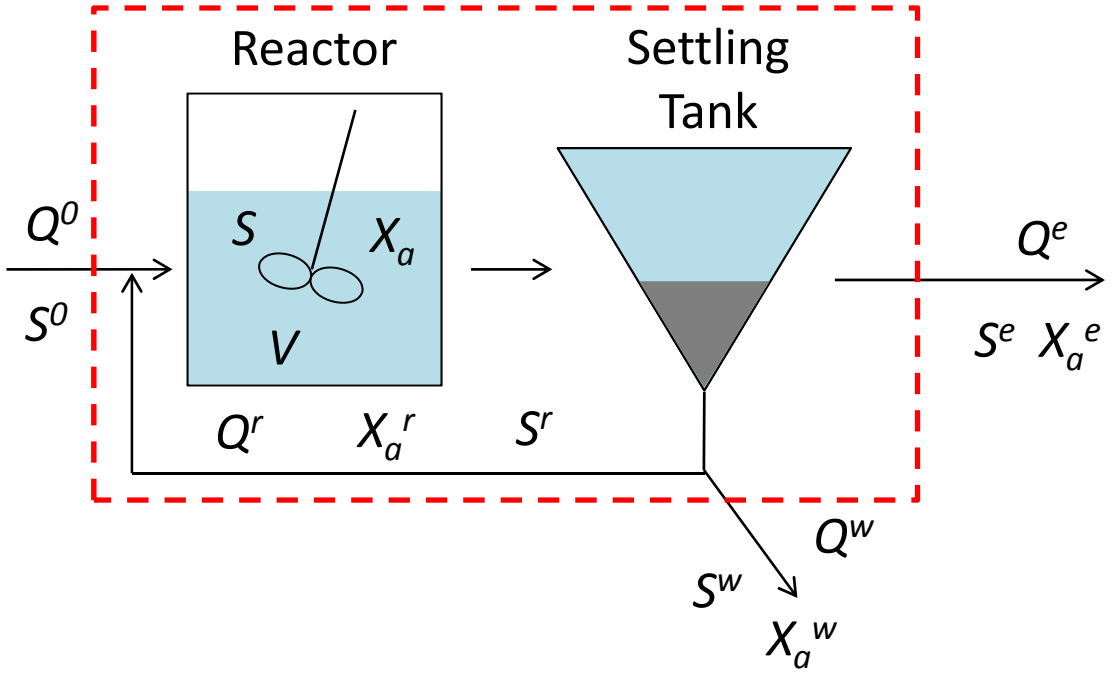
# Microbial kinetics in reactors III

# 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

# 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:

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

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

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

# 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