

Dynamic simulation of microbial growth
Instructor: Nam Sun Wang

Operating conditions:

$$s_f := 200 \quad \dots \text{Feed substrate concentration}$$

$$D := 0.1 \quad \dots \text{Dilution rate}$$

Constitutive relations:

$$\mu_m := 0.3 \quad \dots \text{maximum specific growth rate}$$

$$K := 50 \quad \dots \text{Michaelis-Menten constant}$$

$$A := 0.004 \quad \dots \text{constant part of yield coefficient}$$

$$B := 0.001 \quad \dots \text{linear part of yield coefficient}$$

$$\mu(s) := \frac{\mu_m \cdot s}{K + s} \quad \dots \text{Monod specific growth rate}$$

$$Y(s) := A + B \cdot s \quad \dots \text{yield coefficient}$$

Dynamic Equations:

$$dxdt(x, s) := (\mu(s) - D) \cdot x$$

$$dsdt(x, s) := D \cdot (s_f - s) - \frac{\mu(s)}{Y(s)} \cdot x$$

Combine individual functions into a vector function suitable for Mathcad's "rkfixed"

$$ydot(t, y) := \begin{pmatrix} dxdt(y_0, y_1) \\ dsdt(y_0, y_1) \end{pmatrix}$$

Initial conditions: $x_0 := 0.5$ $s_0 := 30$

$$y \text{ initial} := \begin{pmatrix} x_0 \\ s_0 \end{pmatrix} \quad \dots \text{biomass} \\ \dots \text{substrate}$$

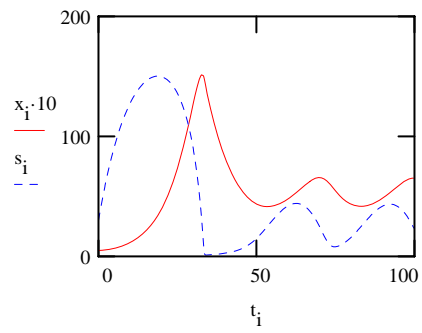
Solve both sets of ODEs from $t_0 := 0$ to $t_f := 100$ in $nstep := 1000$

$yout := rkfixed(y_{initial}, t_0, t_f, nstep, ydot)$

Extract each variable from columns of "yout"

$t := yout^{<0>} \quad x := yout^{<1>} \quad s := yout^{<2>}$

Plots of state variables $i := 0..last(t)$



Phase diagram

