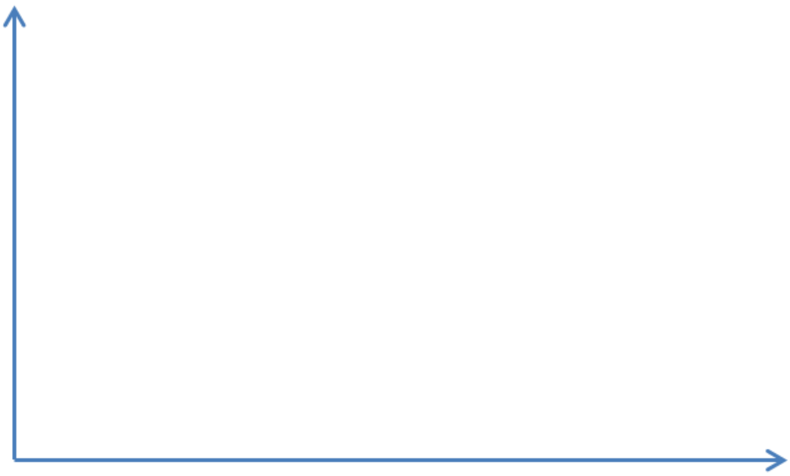
Contacts: eveline.mayner@epfl.ch
manfred.zinn@epfl.ch

Biochemical Engineering

Exercise Session 7

1) Chemostat Theory

Draw a x-D diagram with consideration of maintenance energy and insert, biomass, volumetric productivity, specific productivity, residual glucose concentration s, D_{opt} and D_{crit}.



What do you understand under a turbidostat and a pH auxostat?
What are their differences to a chemostat?

2) Substrate conversion and biomass productivity

A 5 m^3 fermenter is operated continuously with a feed substrate concentration of 20 kg m^{-3}. The genetically engineered *E. coli* cultivated in the reactor has the following characteristics:

μ_{max} = 0.45 h^{-1}; K_S = 800 g m^{-3}; $Y_{X/S}$ = 0.55 kg kg^{-1}

a) What feed flow rate is required to achieve 90% substrate conversion?
b) How does the biomass productivity at 90% substrate conversion compare with the maximum possible?
c) What is the biomass concentration in case a) and at the optimal dilution rate?

3) Growth inhibition

The specific growth rate for inhibited growth in a chemostat is given by the following equation:

$$\mu = \mu_{max} S /(K_s + S + I K_s / K_i)$$

Where

$s_0 = 10$ g L^{-1}, $K_s = 1$ g L^{-1}; $I = 0.05$ g L^{-1}, $Y_{xs} = 0.1$ g g^{-1}
$x_0 = 0$, $K_i = 0.01$ g L^{-1}, $\mu_{max} = 0.5$ h^{-1}

a) Determine x and s as function of D when I = 0.
b) With inhibitor added to a chemostat, determine the effluent substrate concentration and x as function of D.
c) Determine the volumetric cell productivity, DX, as a function of dilution rate.

4) Wash-out experiment

What is the biomass concentration in a chemostat when one knows the following parameters:

V = 2.2 L F = 200 mL/h
s_0 = 10 g glucose/L μ_{max} = 0.3 h^{-1}
K_s = 0.2 g glucose/L $Y_{X/S}$ = 0.5 g cells / g glucose
(consider not metabolized glucose s!)

What is the concentration of the biomass at different times when the dilution rate was changed to D = 1.0 h^{-1}? Fill in the table below.

Time [h]	Biomass concentration [mg L^{-1}] (3 digits after the comma !)
1	
5	
15	
25	