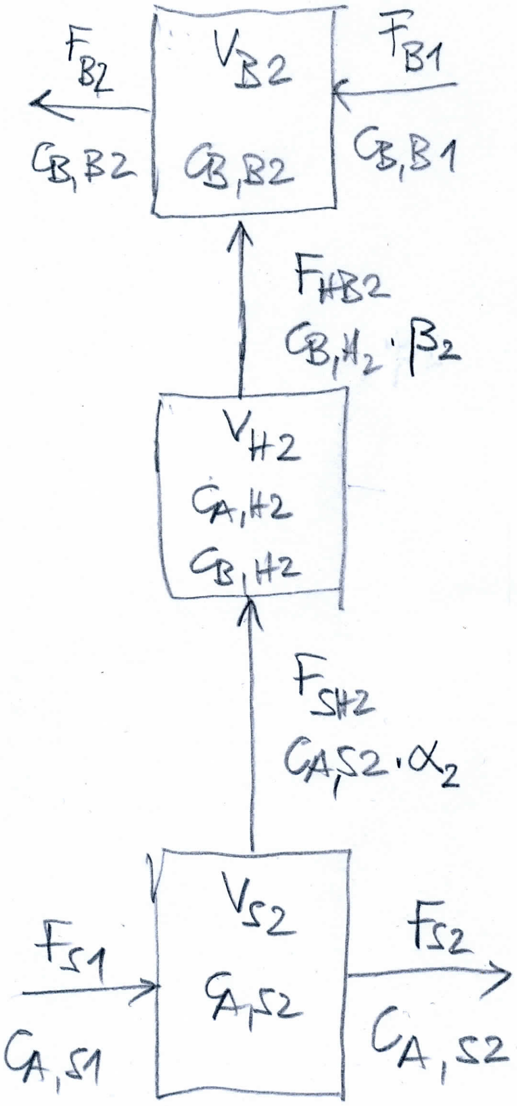
9.5.1

Exercise 1:



$$\frac{dV_i}{dt} = 0$$

$$V_{B2} \cdot \frac{dc_{B,B2}}{dt} = F_{B1} \cdot c_{B,B1} - F_{B2} \cdot c_{B,B2} + F_{HB2} \cdot c_{B,H_2}$$

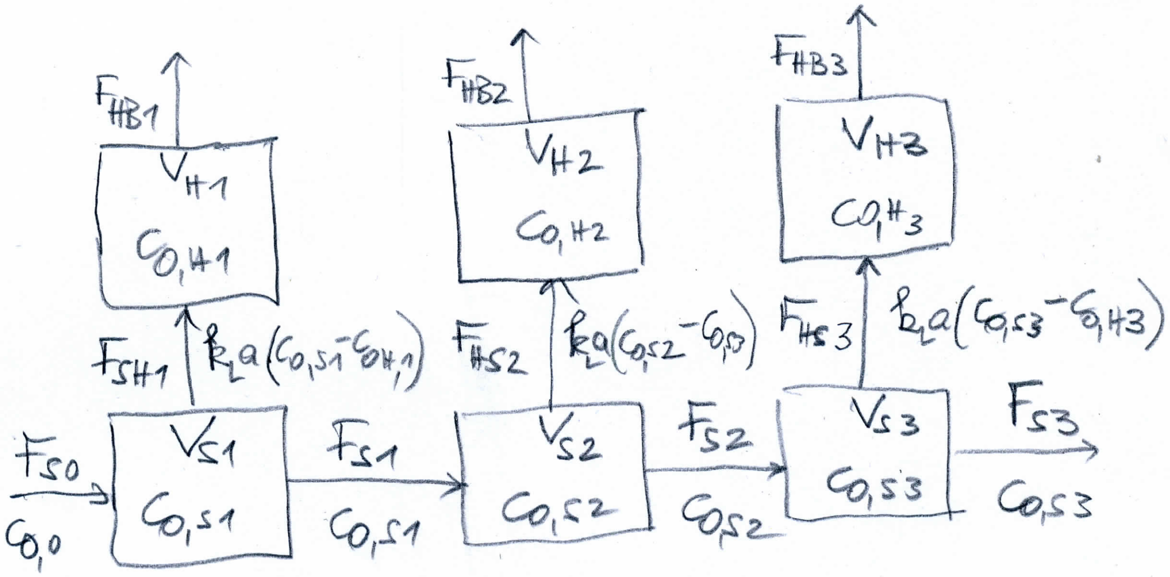
$$V_{H_2} \cdot \frac{dc_{A,H_2}}{dt} = F_{SH2} \cdot c_{A,S2} \cdot \alpha_2 - r_{A,H_2} \cdot V_{H2}$$

$$V_{H2} \cdot \frac{dc_{B,H_2}}{dt} = r_{B,H_2} V_{H_2} - F_{HB2} \cdot c_{B,H_2} \cdot \beta_2$$

$$V_{S2} \frac{dc_{A,S2}}{dt} = -F_{SH2} \cdot c_{A,S2} \cdot \alpha_2 + F_{S1} \cdot c_{A,S1} - F_{S2} \cdot c_{A,S2}$$

Exercise 2:

We have to add oxygen balances to the sinusoid and hepatocyte balance regions. For oxygen transfer from the sinusoid to the hepatocytes we can use a diffusion model in the form of $k_L a$, with k_L as transfer coefficient and a as specific transfer area. The basic model structure remains the same.



Kinetics:

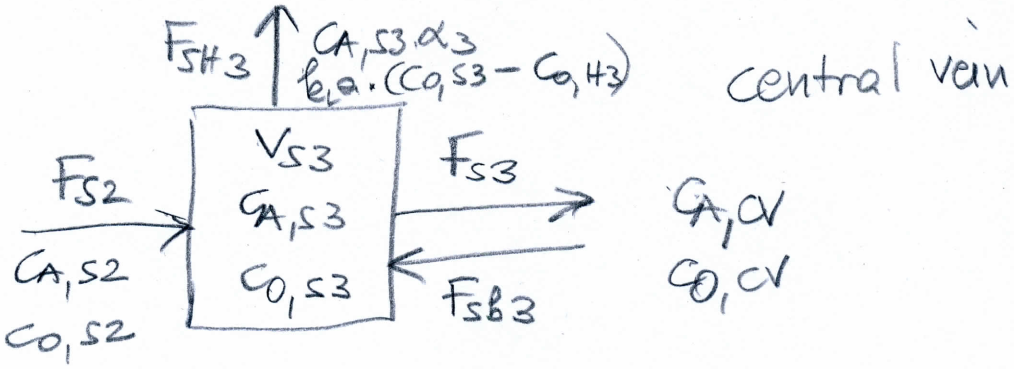
$$r_{O,H2} = r_{O,max} \frac{c_{A,H2}}{K_{SA} + c_{A,H2}} \cdot \frac{c_{O,H2}}{K_{SO} + c_{O,H2}}$$

Balance H2

$$V_{H2} \cdot \frac{dc_{O,H2}}{dt} = k_L a(c_{O,S2} - c_{O,H2}) \cdot V_{S2} - r_{O,H2} \cdot V_{H2}$$

Exercise 3:

Just modify sinusoidal element S3



total mass balance

$$F_{S,2} + F_{Sb} - F_{SH2} - F_{S3} = 0$$

Balance A

$$V_{S,3} \frac{dC_{A,S3}}{dt} = F_{S2} \cdot C_{A,S2} - F_{SH3} \cdot C_{A,S3} \cdot \alpha_3 - F_{S3} \cdot C_{A,S3} + F_{Sb3} \cdot C_{A,CV}$$

Balance oxygen

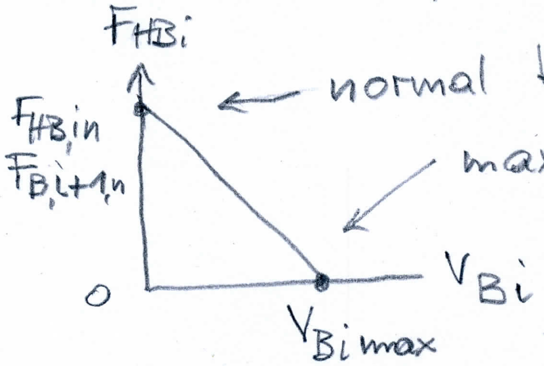
$$V_{S,3} \frac{dC_{O,S3}}{dt} = F_{S2} \cdot C_{O,S2} - k_L a \left(C_{O,S3} - C_{O,H3}\right) \cdot V_{S3} - F_{S3} \cdot C_{O,S3} + F_{Sb3} \cdot C_{O,CV}$$

Exercise 4:

We assume that the volume of the bile duct elements isn't any more constant. F_{B1} would be set to 0.

F_{HBi} would be a function of V_{Bi}.

For constant V_{Hi}, $F_{HBi} = F_{SHi}$.



Balance B1: total mass:

$$\rho \frac{dV_{B1}}{dt} = F_{HB1} \cdot \rho + F_{B2}$$

Balance compound B

$$\frac{d(V_{B1} \cdot c_{B,B1})}{dt} = F_{HB1}\, c_{B,H1} \cdot \beta_1 + F_{B2} \cdot c_{B,B2}$$