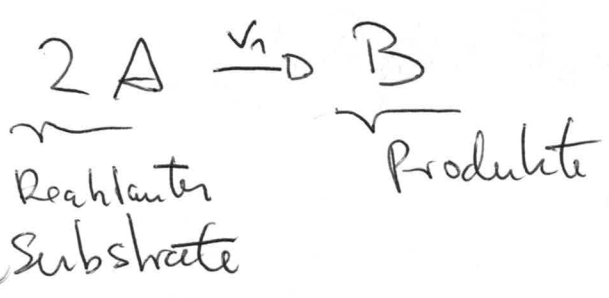


① Relativ
Signaling
Gene Expression

② Models of Relativism

③ Basics: Chemical Kinetics / Physical Chemistry



v_1 : Reaktionsgeschw.

$$\frac{d[A]}{dt} = -2v_1 \quad \frac{d[B]}{dt} = +v_1 \quad \left| \quad \text{also:} \quad \frac{d[B]}{dt} = -\frac{1}{2} \frac{d[A]}{dt} \right.$$

Stöchiometrische Koeffizienten
-2 +1

Beispiel



	A	B	C	Σ
Stöch. Koeff.	-1	-1	+1	Σ

} enthält nicht alle
komplette Info

④ Reaktionsraten

$$v = f([A], [B], \text{etc.}) \quad \text{how: intensive}$$

⑤ Massenwirkungsgesetz

Massenwirkungsgesetz



$$\frac{d[A]}{dt} = -v$$

$$v = k \cdot [A]$$

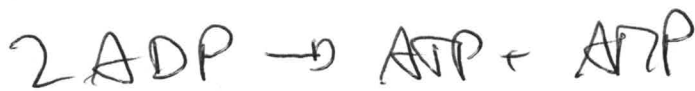


$$v = k^+ [A]^{n_A} \cdot [B]^{n_B} \cdot \dots$$

Mass-action kinetics!

$$\text{Rückreaktion: } v = k^- [P]^{n_P} \cdot [Q]^{n_Q} \cdot \dots$$

BSP



$$v^+ = k^+ \cdot [\text{ADP}]^2$$

$$v^- = k^- [\text{ATP}] [\text{ATP}]$$

Chemical equilibrium

Bsp



$$v^+ = k^+ \cdot [A]$$

$$v^- = k^- \cdot [B]$$

$$v = v^+ - v^- \stackrel{!}{=} 0$$

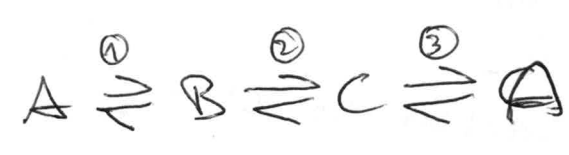
$$\Rightarrow k^+ [A]^0 = k^- [B]^0$$

$$\Rightarrow \frac{k^+}{k^-} = \frac{[B]^0}{[A]^0} = \underline{\underline{K_{eq}}}$$

frei

$$K_{eq} = \frac{[P]^{u_p} \cdot [Q]^{u_q}}{[A]^{u_a} \cdot [B]^{u_b}} = \frac{K^+}{K^-}$$

⑥ Detailed Balance ("detailliertes Gleichgewicht")



$$\frac{k_1^+}{k_1^-} = \frac{B^0}{A^0} = K_{eq1} \quad \frac{k_2^+}{k_2^-} = \frac{C^0}{B^0} = K_{eq2} \quad \frac{k_3^+}{k_3^-} = \frac{A^0}{C^0} = K_{eq3}$$

$$K_{eq1} \cdot K_{eq2} \cdot K_{eq3} = 1 = \frac{k_1^+}{k_1^-} \cdot \frac{k_2^+}{k_2^-} \cdot \frac{k_3^+}{k_3^-}$$

for any cycle: product of forward rate constant = prod of rev. rate constant

$$\prod k_i^+ = \prod k_i^- \quad \text{or} \quad \prod K_{eq} = 1$$

"Wegscheider's condition"

gilt auch für mehrstufige Ketten!

-4-

Mass-action ratio

$$V = V^+ - V^- = V^+ (1 - \frac{V^-}{V^+})$$

$$\frac{V^-}{V^+} = \frac{K^-}{K^+} \frac{[A]^{u_a} [Q]^{u_q} \dots}{[A]^{u_a} [B]^{u_b}}$$

K_{eq} mass-action ratio = $\frac{\Gamma}{K_{eq}}$

$$V = V^+ (1 - \frac{\Gamma}{K_{eq}})$$

Thermodynamic

+

⑦ Slides: Models of Metabolism

unlab NA Bechug

Stationäres Natur

$$\frac{dx}{dt} = N \cdot v$$

Bsp globale

• Eigenschaften von N

• Massenmatrix

lin. abhängig rows!

rank(N)

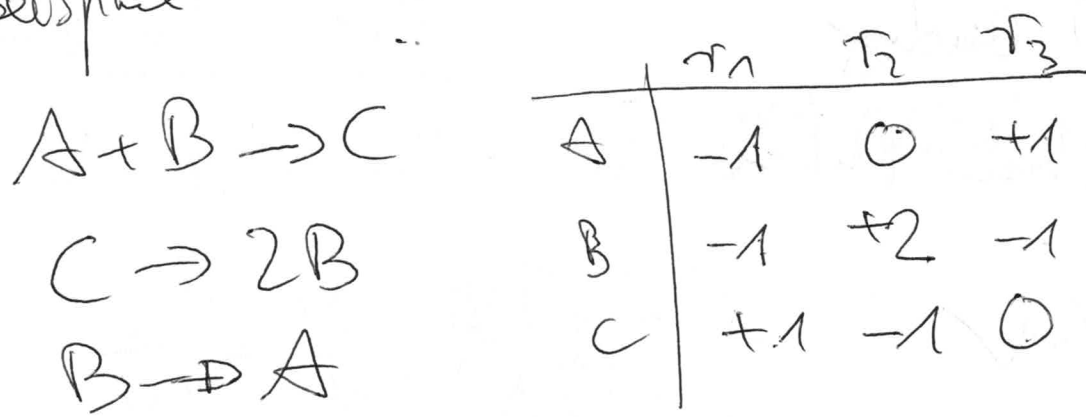
links Nullraum $E \cdot N = 0$

$$\begin{bmatrix} 0 & 0 & 0 & 1 \end{bmatrix} \cdot N = 0$$

$$E \cdot \dot{x} = \cancel{E} \cdot N \cdot v = 0$$

$$E \cdot \begin{bmatrix} \dot{x} \\ \text{ATP} \\ \text{ADP} \end{bmatrix} = \frac{d}{dt} (\text{ATP} + \text{ADP}) = 0$$

Beispiel



$$\text{rank}(N) = 2 =$$

$$E = (1 \ 1 \ 2)$$

$$E \cdot N = 0$$

$$\Rightarrow \frac{d}{dt} \begin{bmatrix} \dot{A} \\ \dot{B} \\ \dot{C} \end{bmatrix} = N \cdot v$$

$$\dot{A} = -r_1 + r_3$$

$$\dot{B} = -r_1 + 2r_2 - r_3$$

$$\dot{C} = +r_1 - r_2$$

$$\Rightarrow \frac{d}{dt} (A + B + 2C) = E \cdot N \cdot v = 0$$

$$\frac{d}{dt} (A + B + 2C) = 0 \Rightarrow A + B + 2C = \text{const}$$

$$-r_1 + r_3 - r_1 + 2r_2 - r_3 + 2(r_1 - r_2) = 0$$

Recht Nullraum

$$N \cdot v \Leftrightarrow N \cdot v^0 = 0$$

$$\tau = \text{rank}(N)$$

typisch $\tau > m$