Important Formulas on Enzyme Kinetics PDF

Formulas
Examples
with Units

List of 26
Important Formulas on Enzyme Kinetics

1) Catalytic Rate Constant from Michaelis Menten Kinetics Equation Formula

Evaluate Formula

Formula

$$k_{cat\_MM} = \frac{V_0 \cdot \left(K_M + S \right)}{[E_0] \cdot S}$$

Example with Units

$$0.0135\,s^{-1} = \frac{0.45\,mol/L*s \cdot \left(3\,mol/L + 1.5\,mol/L \right)}{100\,mol/L \cdot 1.5\,mol/L}$$

2) Catalytic Rate Constant if Substrate Concentration is higher than Michaelis Constant Formula

Evaluate Formula

Formula

$$k_{cat} = \frac{V_{max}}{[E_0]}$$

Example with Units

$$0.4\,s^{-1} = \frac{40\,mol/L*s}{100\,mol/L}$$

3) Dissociation Constant of Enzyme given Modifying Factor of Enzyme Formula

Evaluate Formula

Formula

$$K_{ei} = \frac{I}{\alpha - 1}$$

Example with Units

$$2.25\,mol/L = \frac{9\,mol/L}{5 - 1}$$

4) Dissociation Rate Constant in Enzymatic Reaction Mechanism Formula

Evaluate Formula

Formula

$$K_D = \frac{k_r}{k_f}$$

Example with Units

$$2.8986\,mol/L = \frac{20\,mol/L*s}{6.9\,s^{-1}}$$

5) Enzyme Catalyst Concentration given Forward, Reverse, and Catalytic Rate Constants Formula

Evaluate Formula

Formula

$$E = \frac{\left(k_r + k_{cat} \right) \cdot ES}{k_f \cdot S}$$

Example with Units

$$19.3243\,mol/L = \frac{\left(20\,mol/L*s + 0.65\,s^{-1} \right) \cdot 10\,mol/L}{6.9\,s^{-1} \cdot 1.5\,mol/L}$$

6) Enzyme Concentration from Michaelis Menten Kinetics equation Formula

Evaluate Formula

Formula

$$[E_i] = \frac{V_0 \cdot \left(K_M + S \right)}{k_{cat} \cdot S}$$

Example with Units

$$2.0769\,\text{mol/L} = \frac{0.45\,\text{mol/L*s} \cdot \left(3\,\text{mol/L} + 1.5\,\text{mol/L} \right)}{0.65\,\text{s}^{-1} \cdot 1.5\,\text{mol/L}}$$

7) Enzyme Substrate Complex Concentration for Competitive Inhibition of Enzyme Catalysis Formula

Evaluate Formula

Formula

$$ES = \frac{S \cdot [E_0]}{K_M \cdot \left(1 + \left(\frac{I}{K_i} \right) \right) + S}$$

Example with Units

$$25.3333\,\text{mol/L} = \frac{1.5\,\text{mol/L} \cdot 100\,\text{mol/L}}{3\,\text{mol/L} \cdot \left(1 + \left(\frac{9\,\text{mol/L}}{19\,\text{mol/L}} \right) \right) + 1.5\,\text{mol/L}}$$

8) Final Rate Constant for Competitive Inhibition of Enzyme Catalysis Formula

Evaluate Formula

Formula

$$k_{final} = \frac{V_0 \cdot \left(K_M \cdot \left(1 + \left(\frac{I}{K_i} \right) \right) + S \right)}{[E_0] \cdot S}$$

Example with Units

$$0.0178\,\text{s}^{-1} = \frac{0.45\,\text{mol/L*s} \cdot \left(3\,\text{mol/L} \cdot \left(1 + \left(\frac{9\,\text{mol/L}}{19\,\text{mol/L}} \right) \right) + 1.5\,\text{mol/L} \right)}{100\,\text{mol/L} \cdot 1.5\,\text{mol/L}}$$

9) Forward Rate Constant given Dissociation Rate Constant Formula

Evaluate Formula

Formula

$$k_f = \left(\frac{k_r}{K_D} \right)$$

Example with Units

$$3.5088\,\text{s}^{-1} = \left(\frac{20\,\text{mol/L*s}}{5.7\,\text{mol/L}} \right)$$

10) Inhibitor Concentration for Competitive Inhibition of Enzyme Catalysis Formula

Evaluate Formula

Formula

$$I_{IEC} = \left(\left(\frac{\left(\frac{k_2 \cdot [E_0] \cdot S}{V_0} \right) - S}{K_M} \right) - 1 \right) \cdot K_i$$

Example with Units

$$48527.0556\,\text{mol/L} = \left(\left(\frac{\left(\frac{23\,\text{s}^{-1} \cdot 100\,\text{mol/L} \cdot 1.5\,\text{mol/L}}{0.45\,\text{mol/L*s}} \right) - 1.5\,\text{mol/L}}{3\,\text{mol/L}} \right) - 1 \right) \cdot 19\,\text{mol/L}$$

11) Inhibitor Concentration given Apparent Initial Enzyme Concentration Formula

Evaluate Formula

Formula

$$I_{CI} = \left(\left(\frac{[E_0]}{E0^{app}}\right) - 1\right) \cdot K_i$$

Example with Units

$$31647.6667\,\text{mol/L} = \left(\left(\frac{100\,\text{mol/L}}{0.06\,\text{mol/L}}\right) - 1\right) \cdot 19\,\text{mol/L}$$

12) Inhibitor Concentration given Enzyme Substrate Modifying Factor Formula

Evaluate Formula

Formula

$$I = \left(\alpha' - 1\right) \cdot K_i'$$

Example with Units

$$15\,\text{mol/L} = \left(2 - 1\right) \cdot 15\,\text{mol/L}$$

13) Inhibitor Concentration in Competitive Inhibition given Maximum Rate of System Formula

Evaluate Formula

Formula

$$I_{max} = \left(\left(\frac{\left(\frac{V_{max} \cdot S}{V_0}\right) - S}{K_M}\right) - 1\right) \cdot K_i$$

Example with Units

$$815.9444\,\text{mol/L} = \left(\left(\frac{\left(\frac{40\,\text{mol/L*s} \cdot 1.5\,\text{mol/L}}{0.45\,\text{mol/L*s}}\right) - 1.5\,\text{mol/L}}{3\,\text{mol/L}}\right) - 1\right) \cdot 19\,\text{mol/L}$$

14) Initial Concentration of Enzyme in presence of Inhibitor by Enzyme Conservation Law Formula

Evaluate Formula

Formula

$$[E_{initial}] = \left(E + ES + EI\right)$$

Example with Units

$$64\,\text{mol/L} = \left(25\,\text{mol/L} + 10\,\text{mol/L} + 29\,\text{mol/L}\right)$$

15) Initial Enzyme Concentration if Substrate Concentration is Higher than Michaelis Constant Formula

Evaluate Formula

Formula

$$[E_{initial}] = \frac{V_{max}}{k_{cat}}$$

Example with Units

$$61.5385\,\text{mol/L} = \frac{40\,\text{mol/L*s}}{0.65\,\text{s}^{-1}}$$

16) Initial Enzyme Concentration given Dissociation Rate Constant Formula

Evaluate Formula

Formula

$$[E_{initial}] = \frac{ES \cdot \left(K_D + S\right)}{S}$$

Example with Units

$$48\,\text{mol/L} = \frac{10\,\text{mol/L} \cdot \left(5.7\,\text{mol/L} + 1.5\,\text{mol/L}\right)}{1.5\,\text{mol/L}}$$

17) Initial Rate in Competitive Inhibition given Maximum Rate of system Formula

Evaluate Formula

Formula

$$V_{CI} = \frac{V_{max} \cdot S}{K_M \cdot \left(1 + \left(\frac{I}{K_i}\right)\right) + S}$$

Example with Units

$$10.1333\,\text{mol/L*s} = \frac{40\,\text{mol/L*s} \cdot 1.5\,\text{mol/L}}{3\,\text{mol/L} \cdot \left(1 + \left(\frac{9\,\text{mol/L}}{19\,\text{mol/L}}\right)\right) + 1.5\,\text{mol/L}}$$

18) Initial Rate of System given Rate Constant and Enzyme Substrate Complex Concentration Formula

Evaluate Formula

Formula

$$V_{RC} = k_2 \cdot ES$$

Example with Units

$$230\,\text{mol/L*s} = 23\,\text{s}^{-1} \cdot 10\,\text{mol/L}$$

19) Initial Reaction Rate given Dissociation Rate Constant Formula

Evaluate Formula

Formula

$$V_{DRC} = \frac{V_{max} \cdot S}{K_D + S}$$

Example with Units

$$8.3333\,\text{mol/L*s} = \frac{40\,\text{mol/L*s} \cdot 1.5\,\text{mol/L}}{5.7\,\text{mol/L} + 1.5\,\text{mol/L}}$$

20) Maximum Rate given Dissociation Rate Constant Formula

Evaluate Formula

Formula

$$V_{max\_DRC} = \frac{V_0 \cdot \left(K_D + S\right)}{S}$$

Example with Units

$$2.16\,\text{mol/L*s} = \frac{0.45\,\text{mol/L*s} \cdot \left(5.7\,\text{mol/L} + 1.5\,\text{mol/L}\right)}{1.5\,\text{mol/L}}$$

21) Maximum Rate if Substrate Concentration is Higher than Michaelis Constant Formula

Evaluate Formula

Formula

$$V_{max} = k_{cat} \cdot [E_0]$$

Example with Units

$$65\,\text{mol/L*s} = 0.65\,\text{s}^{-1} \cdot 100\,\text{mol/L}$$

22) Maximum Rate in presence of Noncompetitive Inhibitor Formula

Evaluate Formula

Formula

$$V_{max} = \left(Vmax^{app} \cdot \left(1 + \left(\frac{I}{K_i}\right)\right)\right)$$

Example with Units

$$30.9474\,\text{mol/L*s} = \left(21\,\text{mol/L*s} \cdot \left(1 + \left(\frac{9\,\text{mol/L}}{19\,\text{mol/L}}\right)\right)\right)$$

23) Michaelis Constant given Forward, Reverse, and Catalytic Rate Constants Formula

Evaluate Formula

Formula

$$K_M = \frac{k_r + k_{cat}}{k_f}$$

Example with Units

$$2.8986\,\text{mol/L} = \frac{20\,\text{mol/L*s} + 0.65\,\text{s}^{-1}}{6.9\,\text{s}^{-1}}$$

24) Michaelis Constant in Competitive Inhibition given Enzyme Substrate Complex Concentration Formula

Evaluate Formula

Formula

$$K_M = \frac{\left(\frac{[E_0] \cdot S}{ES}\right) - S}{1 + \left(\frac{I}{K_i}\right)}$$

Example with Units

$$9.1607\,\text{mol/L} = \frac{\left(\frac{100\,\text{mol/L} \cdot 1.5\,\text{mol/L}}{10\,\text{mol/L}}\right) - 1.5\,\text{mol/L}}{1 + \left(\frac{9\,\text{mol/L}}{19\,\text{mol/L}}\right)}$$

25) Modifying Factor of Enzyme Substrate Complex Formula

Evaluate Formula

Formula

$$\alpha' = 1 + \left(\frac{I}{K_i'}\right)$$

Example with Units

$$1.6 = 1 + \left(\frac{9\,\text{mol/L}}{15\,\text{mol/L}}\right)$$

26) Substrate Concentration given Catalytic Rate Constant and Initial Enzyme Concentration Formula

Evaluate Formula

Formula

$$S_o = \frac{K_M \cdot V_0}{\left(k_{cat} \cdot [E_0]\right) - V_0}$$

Example with Units

$$0.0209\,\text{mol/L} = \frac{3\,\text{mol/L} \cdot 0.45\,\text{mol/L*s}}{\left(0.65\,\text{s}^{-1} \cdot 100\,\text{mol/L}\right) - 0.45\,\text{mol/L*s}}$$

Variables used in list of Important Formulas on Enzyme Kinetics above

- $[E_0]$ Initial Enzyme Concentration *(Mole per Liter)*
- $[E_i]$ Initial Concentration of Enzyme *(Mole per Liter)*
- $[E_{initial}]$ Enzyme Concentration Initially *(Mole per Liter)*
- **E** Catalyst Concentration *(Mole per Liter)*
- $E0^{app}$ Apparent Initial Enzyme Concentration *(Mole per Liter)*
- **EI** Enzyme Inhibitor Complex Concentration *(Mole per Liter)*
- **ES** Enzyme Substrate Complex Concentration *(Mole per Liter)*
- **I** Inhibitor Concentration *(Mole per Liter)*
- I_{CI} Inhibitor Concentration for CI *(Mole per Liter)*
- I_{IEC} Inhibitor Concentration given IEC *(Mole per Liter)*
- I_{max} Inhibitor Concentration given Max Rate *(Mole per Liter)*
- k_2 Final Rate Constant *(1 Per Second)*
- k_{cat} Catalytic Rate Constant *(1 Per Second)*
- k_{cat_MM} Catalytic Rate Constant for MM *(1 Per Second)*
- K_D Dissociation Rate Constant *(Mole per Liter)*
- K_{ei} Enzyme Inhibitor Dissociation Constant given MF *(Mole per Liter)*
- k_f Forward Rate Constant *(1 Per Second)*
- k_{final} Final Rate Constant for Catalysis *(1 Per Second)*
- K_i Enzyme Inhibitor Dissociation Constant *(Mole per Liter)*
- K_i' Enzyme Substrate Dissociation Constant *(Mole per Liter)*
- K_M Michaelis Constant *(Mole per Liter)*
- k_r Reverse Rate Constant *(Mole per Liter Second)*

Constants, Functions, Measurements used in list of Important Formulas on Enzyme Kinetics above

- Measurement: **Molar Concentration** in Mole per Liter (mol/L)
  Molar Concentration Unit Conversion
- Measurement: **Reaction Rate** in Mole per Liter Second (mol/L*s)
  Reaction Rate Unit Conversion
- Measurement: **First Order Reaction Rate Constant** in 1 Per Second (s^{-1})
  First Order Reaction Rate Constant Unit Conversion

- **S** Substrate Concentration *(Mole per Liter)*
- S_o Concentration of Substrate *(Mole per Liter)*
- V_0 Initial Reaction Rate *(Mole per Liter Second)*
- V_{CI} Initial Reaction Rate in CI *(Mole per Liter Second)*
- V_{DRC} Initial Reaction Rate given DRC *(Mole per Liter Second)*
- V_{max} Maximum Rate *(Mole per Liter Second)*
- V_{max_DRC} Maximum Rate given DRC *(Mole per Liter Second)*
- V_{RC} Initial Reaction Rate given RC *(Mole per Liter Second)*
- $Vmax^{app}$ Apparent Maximum Rate *(Mole per Liter Second)*
- **α** Enzyme Modifying Factor
- **α'** Enzyme Substrate Modifying Factor

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