

# BioSIM' Development Rate Models

## Standardized Parameters

Scale factor	$\Psi$
General Parameters	$k, k_0, k_1, k_2, k_3, k_4$
Sharpe&all Parameters	$H_A, H_L, T_L, T_{k_L}, H_H, T_H, T_{k_H}$
Temperature	$T \text{ }^{\circ}\text{C}$ (or $T_k$ in Kelvin)
Lower	$T_b \text{ }^{\circ}\text{C}$
Optimum	$T_o \text{ }^{\circ}\text{C}$
Upper	$T_m \text{ }^{\circ}\text{C}$
Others	$T_{\omega}$
Temperature scale	$\Delta_T, \Delta_{T_b}, \Delta_{T_m}$
Intermediate computation	$\beta, \beta_1, \beta_2, \Omega$

01• Allahyari ( 2005 )

$$\psi \left( \beta^{k_1} \right) \left( 1 - \beta^{k_2} \right), \quad \beta = \frac{T - T_b}{T_m - T_b}$$

02• Analytis ( 1977 )

$$\psi \left( T - T_b \right)^{k_1} \left( T_m - T \right)^{k_2}$$

03• Angilletta ( 2006 )

$$\psi e^{-\frac{1}{2} \left| \frac{T - T_o}{\Delta T} \right|^k}$$

04• Bieri ( 1983 )

$$\left[ k_1 \left( T - T_b \right) \right] - \left[ k_2 e^{T - T_m} \right]$$

05• Briere1 ( 1999 )

$$\psi T \left( T - T_b \right) \left( T_m - T \right)^{\frac{1}{2}}$$

06• Briere2 ( 1999 )

$$\psi T \left( T - T_b \right) \left( T_m - T \right)^{\frac{1}{k}}$$

07• Damos ( 2008 )

$$\psi \left( k - \frac{T}{10} \right) \left( \frac{T}{10} \right)^k$$

08• Damos ( 2011 )

$$\psi \left( \frac{1}{1 + k_1 T + k_2 T^2} \right)$$

09• Deutsch ( 2008 )

$$\left\{ \begin{array}{ll} \psi \left[ e^{-k (T - T_o)^2} \right] & T \leq T_o \\ \psi \left[ 1 - \left( \frac{T - T_o}{T_o - T_m} \right)^2 \right] & T > T_o \end{array} \right.$$

10• Deva&Higgs

$$\psi \left[ 10^{-\Omega} \left( 1 - k_2 + k_2 \Omega \right) \right], \quad \Omega = \left( \frac{\beta_1 + e^{k_1 \beta_1}}{\beta_2} \right)^2, \quad \beta_1 = \left( \frac{T - T_m}{T_m - T_b} \right) - \left( \frac{1}{1 + 0.28 k_1 + 0.72 \ln(1 + k_1)} \right)$$

$$\beta_2 = \frac{1 + k_1}{1 + 1.5 k_1 + 0.39 k_1^2}$$

11• Hansen ( 2011 )

$$\psi \left\{ \left[ e^{k (T - T_m)} - 1 \right] - \left[ e^{k (T_m - T_b)} - 1 \right] e^{\left( \frac{T - T_m}{\Delta T} \right)} \right\}$$

12• Hilbert&Logan ( 1983 )

$$\psi \left[ \frac{(T - T_b)^2}{(T - T_b)^{2 + k^2}} - e^{-\frac{T_m - (T - T_b)}{\Delta T}} \right]$$

13• Hilbert&LoganIII

$$\Psi \left[ \frac{T^2}{T^2 + k^2} - e^{-\frac{T_m - T}{\Delta T}} \right]$$

14• Huey&Stevenson ( 1979 )

$$\Psi \left( T - T_b \right) \left( 1 - e^{k(T - T_m)} \right)$$

15• Janisch1 ( 1932 )

$$\frac{1}{\Psi} \left( \frac{2}{e^{k(T - T_o)} + e^{-k(T - T_o)}} \right)$$

16• Janisch2 ( 1932 )

$$\frac{1}{\Psi} \left( \frac{2}{k_1^{(T - T_m)} + k_2^{(T_m - T)}} \right)$$

17• Johnson ( 1974 )

$$\Psi \left[ \frac{\beta_1 T_k e^{-\frac{k_1}{T_k}}}{1 + e^{\left( \beta_2 - \frac{k_2}{T_k} \right)}} \right], \quad \beta_1 = \frac{k_2}{(k_2 - k_1) T_{k_o} e^{-\frac{k_1}{T_{k_o}}}}, \quad \beta_2 = \frac{k_2}{T_{k_o}} - \ln \left( \frac{k_2}{k_1} - 1 \right)$$

18• Kontodimas ( 2004 )

$$\Psi \left( T - T_b \right)^2 \left( T_m - T \right)$$

19• Lactin1 ( 1995 )

$$e^{k T} - e^{\left(k T_m - \frac{T_m - T}{\Delta T}\right)}$$

20• Lactin2 ( 1995 )

$$k_1 + e^{k_2 T} - e^{\left(k_2 T_m - \frac{T_m - T}{\Delta T}\right)}$$

21• Lamb ( 1992 )

$$\psi e^{-\frac{1}{2}\left(\frac{T - T_o}{\Delta T_x}\right)^2}, \Delta T_x = \begin{cases} \Delta T_1 & T \leq T_o \\ \Delta T_2 & T > T_o \end{cases}$$

22• Lobry&Rosso&Flandrois ( 1993 )

$$\psi \frac{\left(T - T_m\right)\left(T - T_b\right)^2}{\left(T_o - T_b\right)\left[\left(T_o - T_b\right)\left(T - T_o\right) - \left(T_o - T_m\right)\left(T_o + T_b - 2 T\right)\right]}$$

23• Logan10 ( 1976 )

$$\psi \left( \frac{1}{1 + k_1 e^{-k_2 T}} - e^{-\frac{T_m - T}{\Delta T}} \right)$$

24• Logan6 ( 1976 )

$$\psi \left( e^{k T} - e^{\left(k T_m - \frac{T_m - T}{\Delta T}\right)} \right)$$

25• LoganTb

$$\psi e^{\left(k(T-T_b) - e^{k\frac{T-T_b}{\Delta T}}\right)}$$

26• O'Neill ( 1972 )

$$\psi \beta^k e^{k(1-\beta)}, \beta = \frac{T_m - T}{T_m - T_o}$$

27• Poly1

$$k_0 + k_1 T$$

28• Poly2

$$k_0 + k_1 T + k_2 T^2$$

29• Poly3

$$k_0 + k_1 T + k_2 T^2 + k_3 T^3$$

30• Poly4

$$k_0 + k_1 T + k_2 T^2 + k_3 T^3 + k_4 T^4$$

31• Pradham ( 1946 )

$$\psi e^{-\frac{1}{2}\left(\frac{T-T_o}{\Delta T}\right)^2}$$

32• Ratkowsky ( 1983 )

$$\psi^2 \left[ (T-T_b) \left( 1 - e^{k(T-T_m)} \right) \right]^2$$

33• Regniere ( 1982 )

$$\psi \left[ e^{k\beta} - e^{\left(k - \frac{1-\beta}{\Delta T}\right)} \right], \quad \beta = \frac{T-T_b}{T_m-T_b}$$

34• Regniere ( 1987 )

$$\psi \left[ \left( \frac{1}{1 + e^{\left(k_1 - k_2\beta\right)}} \right) - e^{\left(\frac{\beta-1}{\Delta T}\right)} \right], \quad \beta = \frac{T-T_b}{T_m-T_b}$$

35• Regniere ( 2012 )

$$\psi \left[ e^{k(T-T_b)} - \left( \left( \frac{T_m-T}{T_m-T_b} \right) e^{-k\left(\frac{T-T_b}{\Delta T_b}\right)} \right) - \left( \frac{T-T_b}{T_m-T_b} \right) e^{k(T_m-T_b) - \left(\frac{T_m-T}{\Delta T_m}\right)} \right]$$

36• Room ( 1986 )

$$\psi e^{-k_x(T-T_o)^2}, \quad k_x = \begin{cases} k_1 & T \leq T_o \\ k_2 & T > T_o \end{cases}$$

37• Saint–Amant ( 2021 )

$$\psi e^{\left[ -k_1 \left( T_{\omega} - T \right)^2 + \left( \frac{1}{-k_2 \left( T_m - T \right)} \right) \right]}$$

38• Schoolfield ( 1981 )

$$\frac{\rho_{25} \left[ \frac{T_k}{298} \right] e^{\left( \frac{H_A}{1.987} \right) \left( \frac{1}{298} - \frac{1}{T_k} \right)}}{1 + e^{\left( \frac{H_L}{1.987} \right) \left( \frac{1}{T_L} - \frac{1}{T_k} \right)} + e^{\left( \frac{H_H}{1.987} \right) \left( \frac{1}{T_H} - \frac{1}{T_k} \right)}}$$

39• Sharpe&DeMichele ( 1977 )

$$\frac{\rho_{25} \left[ \frac{T_k}{T_{k_o}} \right] e^{\left( \frac{H_A}{1.987} \right) \left( \frac{1}{T_{k_o}} - \frac{1}{T_k} \right)}}{1 + e^{\left( \frac{H_L}{1.987} \right) \left( \frac{1}{T_{k_L}} - \frac{1}{T_k} \right)} + e^{\left( \frac{H_H}{1.987} \right) \left( \frac{1}{T_{k_H}} - \frac{1}{T_k} \right)}}$$

40• Shi ( 2011 )

$$\psi \left( 1 - e^{-k_1 \left( T - T_b \right)} \right) \left( 1 - e^{k_2 \left( T - T_m \right)} \right)$$

41• Shi ( 2016 )

$$\psi \left( \frac{T_m - T}{T_m - T_o} \right) \left( \frac{T - T_b}{T_o - T_b} \right)^{\left( \frac{T_o - T_b}{T_m - T_o} \right)}$$

42• Stinner ( 1974 )

$$\begin{cases} \psi \frac{1}{1+e^{k_1+k_2T}} & T < T_o \\ \psi \frac{1}{1+e^{k_1+k_2(2 \cdot T_o - T)}} & T \geq T_o \end{cases}$$



43• Taylor ( 1981 )

$$\psi e^{-\frac{1}{2}\left(\frac{T-T_o}{\Delta T}\right)^2}$$

44• Wagner ( 1988 )

$$\frac{\rho_{25}\left(\frac{T_k}{298.15}\right)e^{\left(\frac{H_A}{1.987}\right)\left(\frac{1}{298.15}-\frac{1}{T_k}\right)}}{1+e^{\left(\frac{H_L}{1.987}\right)\left(\frac{1}{T_L}-\frac{1}{T_k}\right)}}$$

45• Wang&Engel ( 1998 )

$$\psi\left[\frac{2\left(T-T_b\right)^{\beta}\left(T_o-T_b\right)^{\beta}-\left(T-T_b\right)^{2\cdot\beta}}{\left(T_o-T_b\right)^{2\cdot\beta}}\right],\quad\beta=\frac{\ln(2)}{\ln\left(\frac{T_m-T_b}{T_o-T_b}\right)}$$

46• Wang&Lan&Ding ( 1982 )

$$\psi\left(\frac{1}{1+e^{-k\left(T-T_o\right)}}\right)\left(1-e^{-\frac{T-T_b}{\Delta T}}\right)\left(1-e^{-\frac{T_m-T}{\Delta T}}\right)$$

47• Yan&Hunt ( 1999 )

$$\psi\left(\frac{T_m-T}{T_m-T_o}\right)\left(\frac{T}{T_o}\right)^{\frac{T_o}{T_m-T_o}}$$

48• Yin ( 1995 )

$$e^{\psi\left(T-T_b\right)^{k_1}\left(T_m-T\right)^{k_2}}$$