

Additional file 1. Description of the contraction models

A1.1. Length-dependence equations of the Land-model

In the Land-model, the calcium sensitivity is given by

$$[Ca^{2+}]_{50} = Ca_{50ref}(1 + \beta_1(\lambda - 1)) \quad (A1.1)$$

where λ is the extension ratio, i.e. the sarcomere length relative to the resting sarcomere length.

The dynamics of the fraction of regulatory troponin C sites with bound calcium is given by

$$\frac{dTRPN}{dt} = k_{TRPN} \left(\left(\frac{[Ca^{2+}]_i}{[Ca^{2+}]_{50}} \right)^{n_{TRPN}} (1 - TRPN) - TRPN \right) \quad (A1.2)$$

The dynamics of the fraction of available crossbridges cycling is given by

$$\frac{dXB}{dt} = k_{xb} \left(permtot (1 - XB) - \frac{1}{permtot} XB \right) \quad (A1.3)$$

where

$$permtot = \sqrt{\left(\frac{TRPN}{TRPN_{50}} \right)^{n_{xb}}} \quad (A1.4)$$

The influence of filament overlap on tension is taken into account by

$$h(\lambda) = \max(0, h'(\min(\lambda, 1.2))) \quad (A1.5)$$

where

$$h'(\lambda) = 1 + \beta_0(\lambda + \min(\lambda, 0.87) - 1.87) \quad (A1.6)$$

When the velocity dependence is not taken into account, the normalised force then becomes

$$F_n = h(\lambda) \times XB \quad (A1.7)$$

and the active tension is given by

$$T_a = T_{ref} \times F_n \quad (A1.8)$$

A1.2. Length-dependence equations of the Niederer-model

Also in the Niederer-model, the Ca-sensitivity, $[Ca^{2+}]_{50}$, is given by Equation (A1.1). The dynamics of the concentration of Ca^{2+} bound to Troponin C site II, $[Ca^{2+}]_{Trpn}$, is given by

$$\frac{d[Ca^{2+}]_{Trpn}}{dt} = k_{on}[Ca^{2+}]_i([Ca^{2+}]_{TrpnMax} - [Ca^{2+}]_{Trpn}) - k_{off}(T)[Ca^{2+}]_{Trpn} \quad (A1.9)$$

where $[Ca^{2+}]_{TrpnMax}$ is the maximum concentration of ions that can bind to Troponin C site II, $[Ca^{+2}]_i$ is the concentration of free Ca^{2+} , T is the tension and

$$k_{off} = k_{refoff} \left(1 - \frac{T}{\gamma T_{ref}} \right) \quad (A1.10)$$

Combined with

$$T_{0Max} = T_{ref} (1 + \beta_0 (\lambda - 1)) \quad (A1.11)$$

where T_{0Max} is the maximum tension at full activation for a given sarcomere length, we get

$$[Ca^{2+}]_{Trpn50} = [Ca^{2+}]_{TrpnMax} \frac{[Ca^{2+}]_{50}}{[Ca^{2+}]_{50} + \frac{k_{refoff}}{k_{on}} \left(1 - \frac{(1 + \beta_0 (\lambda - 1)) \cdot 0.5}{\gamma} \right)} \quad (A1.12)$$

The dynamics of the fraction of actin sites available for crossbridge binding is given by

$$\frac{dz}{dt} = \alpha_0 \left(\frac{[Ca^{2+}]_{Trpn}}{[Ca^{2+}]_{Trpn50}} \right)^{nH} (1 - z) - \alpha_{r1}z - \alpha_{r2} \frac{z^{n_r}}{z^{n_r} + K_Z^{n_r}} \quad (A1.13)$$

which gives

$$z_{Max} = \frac{\frac{\alpha_0}{\left(\frac{[Ca^{2+}]_{Trpn50}}{[Ca^{2+}]_{TrpnMax}} \right)^{nH}} - K_2}{\alpha_{r1} + K_1 + \frac{\alpha_0}{\left(\frac{[Ca^{2+}]_{Trpn50}}{[Ca^{2+}]_{TrpnMax}} \right)^{nH}}} \quad (A1.14)$$

where z_{Max} is the maximum fraction of available actin sites at a given sarcomere length, and

$$K_2 = \alpha_{r2} \frac{z_p^{n_r}}{z_p^{n_r} + K_Z^{n_r}} \left(1 - \frac{z_p}{(z_p^{n_r} + K_Z^{n_r})} \right) \quad (\text{A1.15})$$

$$K_1 = \frac{\alpha_{r2} z_p^{n_r-1} n_r K_Z^{n_r}}{(z_p^{n_r} + K_Z^{n_r})^2} \quad (\text{A1.16})$$

Isometric tension is then defined as

$$T_0 = T_{0Max} \frac{z}{z_{Max}} = T_{ref} (1 + \beta_0 (\lambda - 1)) \cdot \frac{z}{z_{Max}} \quad (\text{A1.17})$$