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

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

where \(\lambda\) 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

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

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

\[
\frac{dXB}{dt} = k_{XB} \left( permot \ (1 - XB) - \frac{1}{permot} \cdot XB \right) \tag{A1.3}
\]

where

\[
permot = \sqrt{\left( \frac{TRPN}{TRPN_{50}} \right)^{n_{xb}}} \tag{A1.4}
\]

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

\[
h(\lambda) = \max \ (0, h' (\min(\lambda, 1.2))) \tag{A1.5}
\]

where

\[
h'(\lambda) = 1 + \beta_0 (\lambda + \min(\lambda, 0.87) - 1.87) \tag{A1.6}
\]

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

\[
F_n = h(\lambda) \times XB \tag{A1.7}
\]

and the active tension is given by

\[
T_a = T_{ref} \times F_n \tag{A1.8}
\]
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, $[Ca^{2+}]_{Trp}$, is given by

$$\frac{d[Ca^{2+}]_{Trp}}{dt} = k_{on} [Ca^{2+}] \left( [Ca^{2+}]_{TrpMax} - [Ca^{2+}]_{Trp} \right) - k_{off} (T) [Ca^{2+}]_{Trp} \quad (A1.9)$$

where $[Ca^{2+}]_{TrpMax}$ 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

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

Combined with

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

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

$$[Ca^{2+}]_{Trp50} = \frac{[Ca^{2+}]_{TrpMax}}{\left( [Ca^{2+}]_{50} \right)} \frac{[Ca^{2+}]_{50}}{k_{ref} \left( 1 - \left( 1 + \beta_0 (\lambda - 1) \right) \frac{0.5}{\gamma} \right)} \quad (A1.12)$$

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

$$\frac{dz}{dt} = \alpha_0 \left( \frac{[Ca^{2+}]_{Trp}}{[Ca^{2+}]_{Trp50}} \right)^{nH} \left( 1 - z \right) - \alpha_1 z - \alpha_2 \frac{z^{n_z}}{z^{n_z} + K_z^{n_z}} \quad (A1.13)$$

which gives

$$z_{\text{max}} = \frac{\alpha_0 \left( \frac{[Ca^{2+}]_{Trp50}}{[Ca^{2+}]_{TrpMax}} \right)^{nH} - K_z}{\alpha_1 + K_1 + \alpha_0} \quad (A1.14)$$
where \( z_{Max} \) is the maximum fraction of available actin sites at a given sarcomere length, and

\[
K_2 = \alpha \frac{z_p^{n_r}}{z_p^{n_r} + K_z^{n_r}} \left( 1 - \frac{z_p^{n_r}}{z_p^{n_r} + K_z^{n_r}} \right) 
\tag{A1.15}
\]

\[
K_1 = \frac{\alpha \zeta \zeta^{n-1}}{z_p^{n_r} + K_z^{n_r}} 
\tag{A1.16}
\]

Isometric tension is then defined as

\[
T_0 = T_{0,Max} \frac{z}{z_{Max}} = T_{ref} \left( 1 + \beta_0 (\lambda - 1) \right) \cdot \frac{z}{z_{Max}} 
\tag{A1.17}
\]