**Supplementary information S8 (table) | Kinetic description of a bistable three-kinase cascade**

Bistability (supplementary information S7 (figure)) emerges from inhibition of the rate of cytoplasmic phosphatase-2 by the active form $M_3P$. The spatio-temporal dynamics of the cascade is described by the reaction-diffusion system (equation 1 in BOX 4 of the main text). Both phosphorylated and unphosphorylated forms of kinases $M_1$, $M_2$ and $M_3$ diffuse in the cytoplasm. The cell radius $L$ = 25 $\mu$m, the diffusion coefficient $D$ is assumed to be equal for all kinase forms, $D$ = 5 $\mu m^2$/sec. Total concentrations of the unphosphorylated ($M_i$) form and phosphorylated form ($M_iP$) are assumed constant on the time scale considered, $M_i + M_iP = M_{tot}$. Eq. 1 can be solved for dimensionless variables $M_iP/M_{tot}$, therefore, in the table the Michaelis constants ($K_{mi}$ and $K_{mpi}$, $i$ =1,2,3) and the maximal activites ($V^i_{phos}$) are normalized by $M_{tot}$.

| Reaction | Rate expression | Kinetic constants |
|---|---|---|
| Membrane kinase<br>$M_1 \to M_1P$ | $v^{mem}_{kin} = \frac{V^{mem}_{kin} M_1}{(K_{m1} + M_1)}$ | $V^{mem}_{kin} / M_{tot}$ = (1.5 $L$/3) $\mu$m $s^{-1}$<br>$K_{m1}/M_{tot} = 0.5$ |
| Cytoplasmic phosphatase-1<br>$M_1P \to M_1$ | $v^1_{phos} = \frac{V^1_{phos} M_1P}{(K_{mp1} + M_1P)}$ | $V^1_{phos} / M_{tot} = 3\ s^{-1}$<br>$K_{mp1}/M_{tot} = 0.7$ |
| Kinase $M_1P$<br>$M_2 \to M_2P$ | $v^1_{kin} = \frac{k^{cat}_2 M_1P \cdot M_2}{(K_{m2} + K_2)}$ | $k^{cat}_2 = 9\ s^{-1}$<br>$K_{m2}/M_{tot} = 0.7$ |
| Cytoplasmic phosphatase-2<br>$M_2P \to M_2$ | $v^2_{phos} = V^2_{phos} \frac{M_2P}{(K_{mp2} + M_2P)(1 + (M_3P/K_I)^2)}$ | $V^2_{phos} / M_{tot} = 9\ s^{-1}$<br>$K_{mp2}/M_{tot} = 0.7$, $K_I/M_{tot} = 0.15$ |
| Kinase $M_2P$<br>$M_3 \to M_3P$ | $v^2_{kin} = \frac{k^{cat}_3 M_2P \cdot M_3}{(K_{m3} + M_3)}$ | $k^{cat}_3 = 9\ s^{-1}$<br>$K_{m3}/M_{tot} = 0.5$ |
| Cytoplasmic phosphatase-3<br>$M_3P \to M_3$ | $v^3_{phos} = V^3_{phos} \frac{M_3P}{(K_{mp3} + M_3P)}$ | $V^3_{phos} / M_{tot} = 3\ s^{-1}$<br>$K_{mp3}/M_{tot} = 0.7$ |

The traveling wave shown in BOX 4 of the main text (see figure, panel B) was calculated for the input impulse of $V^{mem}_{kin} / M_{tot}$ = (7.5 $L$/3) $\mu$m $s^{-1}$ in the time range from 0 to 30 sec, and $V^{mem}_{kin} / M_{tot} = 0$ at t > 30 s, using the reaction diffusion equations (equation 1 in BOX 4) with the rate expressions and parameters given in supplementary information S8 (table). Note that in the absence of bistability, the phosphorylation signal cannot reach the distance of 20 $\mu$m, since it will be terminated by cytoplasmic phosphatases.