**Supplementary File 1**

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| **Parameter** | **Default Value** | **Parameter Range for ABC** | **Reference** |
| ***Parameters for phosphorylated RII subunits*** | | | |
| k12 (pRII-C + cAMP  pRII-C-cAMP) | 0.496 μM-1 s-1 | 4.96x10-4 to 4.96x102 μM-1 s-1 | (Isensee et al., 2018) |
| k21 (pRII-C + cAMP  pRII-C-cAMP) | 1.43 s-1 | 1.43x10-3 to 1.43x103 s-1 |
| k23 (pRII-cAMP + C  pRII-C-cAMP) | 1.56x10-2 μM-1 s-1 | 1.56x10-5 to 1.56x101 μM-1 s-1 | (Zhang et al., 2012) |
| k32 (pRII-cAMP + C  pRII-C-cAMP) | 5.45x10-3 s-1 | 5.45x10-6 to 5.45 s-1 |
| k43 (pRII + cAMP  pRII-cAMP) | 0.015 μM-1 s-1 | 1.5x10-5 to 1.5x101 μM-1 s-1 | Ogreid & Doskeland, 1981) (Isensee et al., 2018) |
| k34 (pRII + cAMP  pRII-cAMP) | 1.60x10-3 s-1 | 1.60x10-6 to 1.60 s-1 |
| k41 (pRII + C  pRII-C) | 3.8x10-2 μM-1 s-1 | 3.80x10-5 to 3.8x101 μM-1 s-1 | (Zhang et al., 2015) |
| k14 (pRII + C  pRII-C) | 2.60x10-3 s-1 | 2.60x10-6 to 2.60 s-1 |
| KD12 | 0.7 μM | 0.35 to 1.4 μM | (Zhang et al., 2012) |
| ***Parameters for dephosphorylated RII subunits*** | | | |
| k56 (RII-C + cAMP  RII-C-cAMP) | 0.496 μM-1 s-1 | 4.96x10-4 to 4.96x102 μM-1 s-1 | (Isensee et al., 2018) |
| k65 (RII-C + cAMP  RII-C-cAMP) | 1.43 s-1 | 1.43x10-3 to 1.43x103 s-1 |
| k76 (RII-cAMP + C  RII-C-cAMP) | 2.98x10-1 μM-1 s-1 | 2.98x10-4 to 2.984x102 μM-1 s-1 | (Zhang et al., 2015; Zhang et al., 2012) |
| k67 (RII-cAMP + C  RII-C-cAMP) | 1.80x10-2 s-1 | 1.80x10-5 to 1.80x101 s-1 |
| k87 (RII + cAMP  RII-cAMP) | 0.015 μM-1 s-1 | 1.5x10-5 to 1.5x101 μM-1 s-1 | (Ogreid & Doskeland, 1981) |
| k78 (RII + cAMP  RII-cAMP) | 1.60x10-3 s-1 | 1.60x10-6 to 1.60 s-1 |
| k85 (RII + C  RII-C) | 2.10 μM-1 s-1 | 2.10x10-3 to 2.1x103 μM-1 s-1 | (Zhang et al., 2015) |
| k58 (RII + C  RII-C) | 3.0x10-4 s-1 | 3.0x10-7 to 3.0x101 s-1 |
| ***Parameters for phosphorylation of RII subunits*** | | | |
| k51 (RII-C pRII-C) | 33 s-1 | 3.30x10-2 to 3.30x104 s-1 | (Moore et al., 2003) |
| k62 (RII-C-cAMP  pRII-C-cAMP) | 33 s-1 | 3.30x10-2 to 3.30x104 s-1 |
| ***Parameters for dephosphorylation of RII subunits*** | | | |
| k44’ (pRII + CaN  pRII-CaN) | 0.226 μM-1 s-1 | 2.26x10-4 to 2.26x102 μM-1 s-1 | (Stemmer & Klee, 1994) |
| k4’4 (pRII + CaN  pRII-CaN) | 20 s-1 | 2.0x10-2 to 2.0x104 s-1 |
| k33’ (pRII-cAMP + CaN  pRII-cAMP-CaN) | 0.226 μM-1 s-1 | 2.26x10-4 to 2.26x102 μM-1 s-1 | Equal to k44’ |
| k3’3 (pRII-cAMP + CaN  pRII-cAMP-CaN) | 20 s-1 | 2.0x10-2 to 2.0x104 s-1 | Equal to k4’4 |
| k4’8 (pRII-CaN  RII + CaN) | 2.6 s-1 | 2.6x10-3 to 2.6x103 s-1 | (Stemmer & Klee, 1994) |
| k3’7 (pRII-cAMP-CaN  RII-cAMP + CaN) | 2.6 s-1 | 2.6x10-3 to 2.6x103 s-1 |
| KMwithout (without AKAP79) | 100 μM | 66.7 to 150 μM | This study; Stemmer & Klee, 1994) |
| ***Parameters for dephosphorylation of RII subunits when AKAP79 is present*** | | | |
| k44’-AKAP (pRII + CaN  pRII-CaN) | 2.33 μM-1 s-1 | 2.33x10-3 to 2.33x103 μM-1 s-1 | This study |
| k4’4-AKAP (pRII + CaN  pRII-CaN) | 2 s-1 | 2.0x10-3 to 2.0x103 s-1 |
| k33’-AKAP (pRII-cAMP + CaN  pRII-cAMP-CaN) | 2.33 μM-1 s-1 | 2.33x10-3 to 2.33x103 μM-1 s-1 | Equal to k44’-AKAP |
| k3’3-AKAP (pRII-cAMP + CaN  pRII-cAMP-CaN) | 2 s-1 | 2.0x10-3 to 2.0x103 s-1 | Equal to k33’-AKAP |
| k4’8-AKAP (pRII-CaN  RII + CaN) | 0.45 s-1 | 0.237 to 0.855 s-1 | This study |
| k3’7-AKAP (pRII-CaN  RII + CaN) | 0.45 s-1 | 0.237 to 0.855 s-1 | This study |
| KMwith (when AKAP79 is present) | 1 μM | 0.67 to 1.5 μM | This study |
| ***Parameters for AKAR4 phosphorylation*** | | | |
| AKAR4 + C  AKAR4-C | 1.82x10-2 μM-1 s-1 | Fixed | This study |
| AKAR4 + C  AKAR4-C | 0.106 s-1 | Fixed |
| AKAR4-C  pAKAR4 + C | 10.2 s-1 | Fixed |