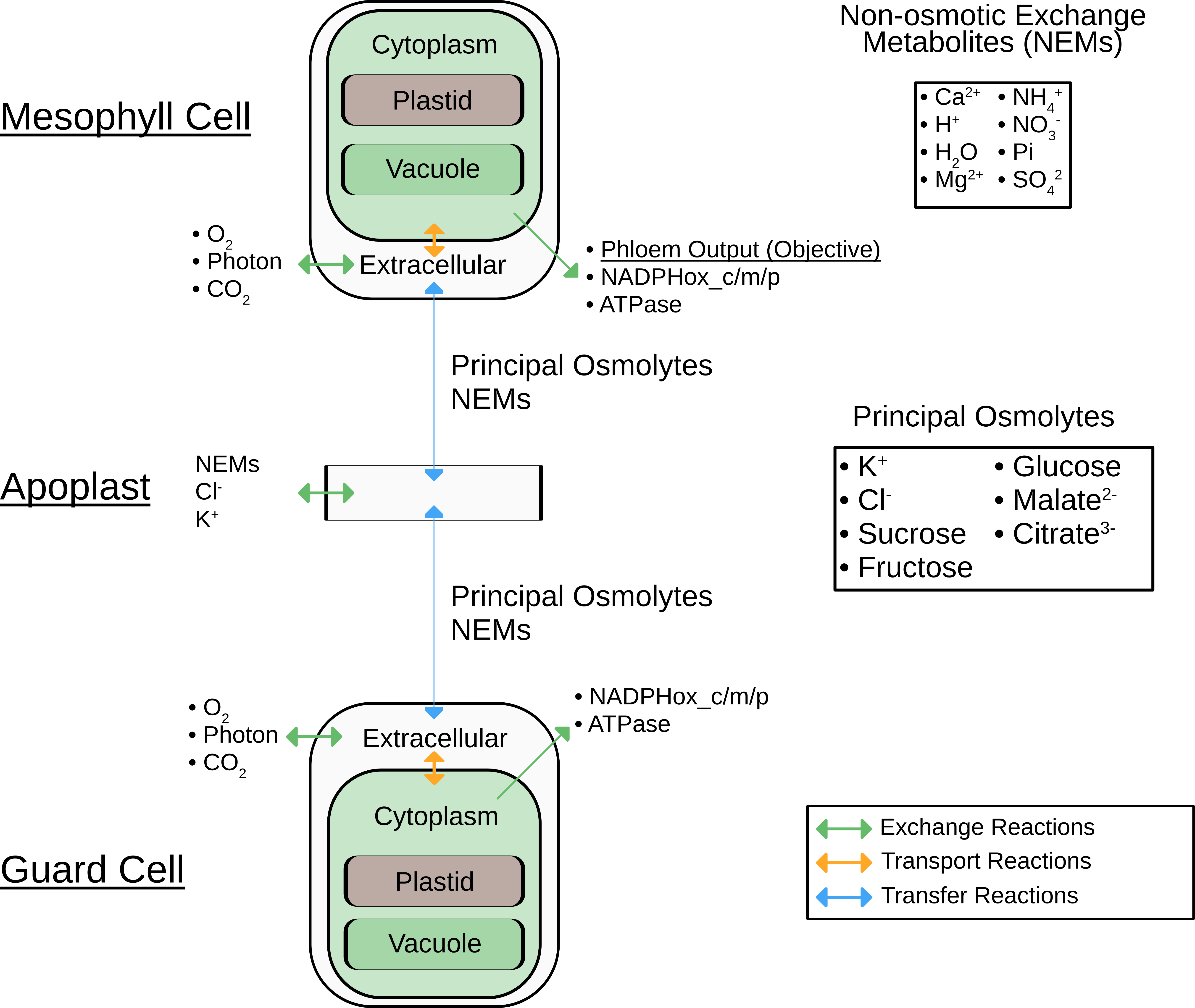
**Supplemental Table 1. List of linker reactions.**

Osmotic coefficient refers to whether or not the linker reaction contributes to osmolarity. a, Apoplast; gc, Guard cell; me, Mesophyll cell; p, Plastid; v, Vacuole; c, Cytosol.

|  |  |  |  |
| --- | --- | --- | --- |
| Osmotic Coefficient | Cell | Compartment | Metabolites |
| 0 | a | NA | Cl, Fructose, Glucose, K, Malate, Nitrate, Sucrose, aMalate |
| gc | p | Starch |
| me | p | Starch |
| v | 4\_amino\_butyrate, Arg, Asn, Citrate, Cys, Gln, Glt, Gly, His, Ile, Leu, Lys, L\_alpha\_alanine, L\_aspartate, Malate, Met, Phe, Pro, Ser, Sucrose, Thr, Trp, Tyr, Val, aCitrate, aMalate, bHis |
| 1 | gc | c | Citrate, Cl, Fructose, Glucose, K, Malate, Nitrate, Sucrose |
| v | 4\_amino\_butyrate, Arg, Asn, Citrate, Cys, Cl, Fructose, Glucose, Gln, Glt, Gly, His, Ile, K, Leu, Lys, L\_alpha\_alanine, L\_aspartate, Malate, Met, Nitrate, Phe, Pro, Ser, Sucrose, Thr, Trp, Tyr, Val, aCitrate, aMalate, bHis |

**Supplemental Figure 1. Transfer metabolites and ions**

The diagram shows one phase of the model. Transfer reactions occur between cell types, transport reactions occur between compartments within a cell, exchange reactions are uptake into and excretion from the model. For full details of implementation see Supplemental Code.



**Supplemental Figure 2. Transporters and channels in guard cell model**

We combined transporters from three sources and incorporated them into the model if not already

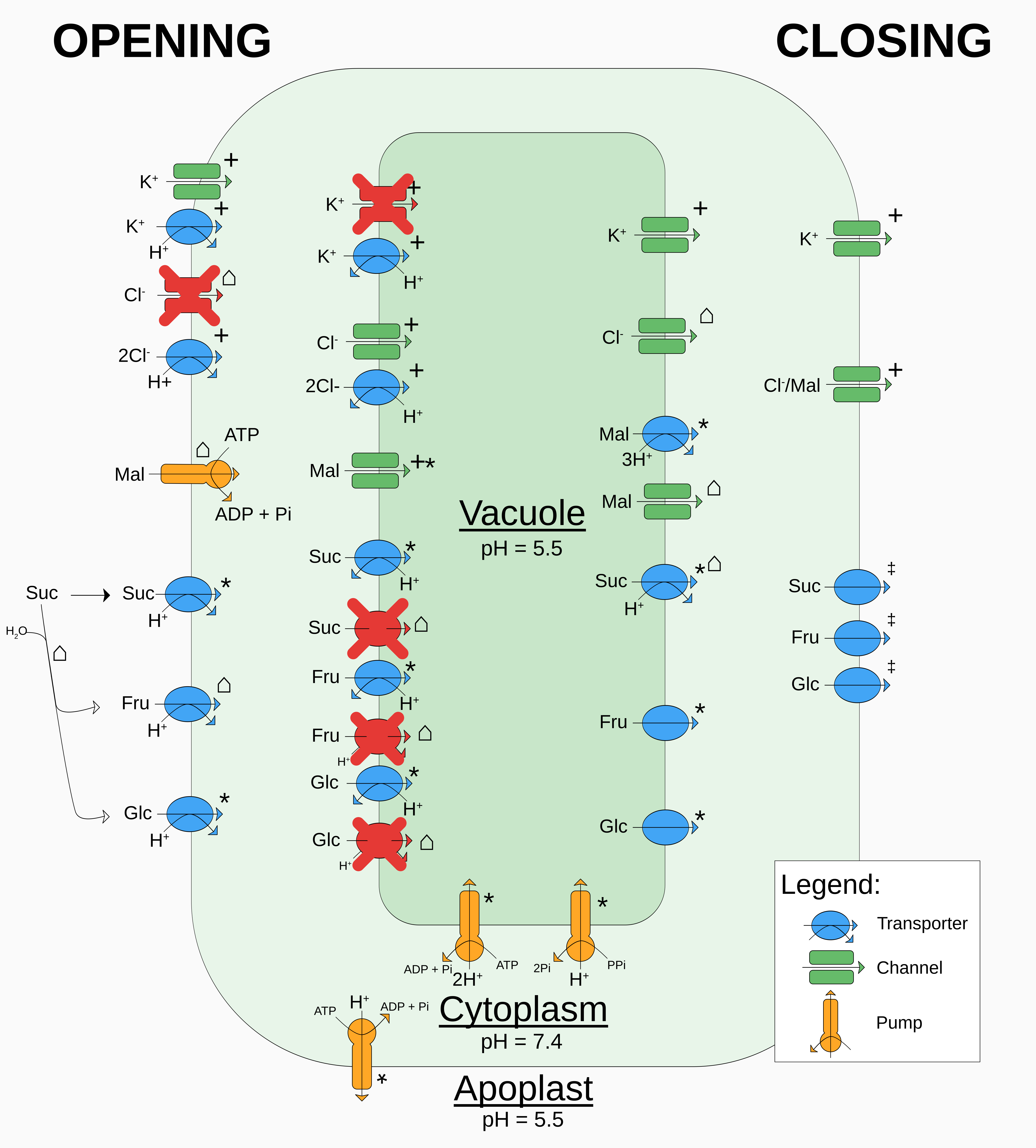
present. Red crosses indicate transport reactions that were considered to be thermodynamically

infeasible, and through which flux was constrained to 0. Although the transporters are displayed

under ‘Opening’ and ‘Closing’ for convenience, they were not segregated as such in the model,

and where the same transporter is displayed in both ‘Opening’ and ‘Closing’, the reaction was

defined as reversible. pH values for the compartments remained as in Shameer et al (2018). Sources: \* - Present in core model; ⌂ - Santelia and Lawson (2016); + - OnGuard (Hills et al., 2012); ‡ - SWEET (Feng and Frommer, 2015). For full details see Supplemental Code.



**Supplemental Table 2. Parameter bounds for parameter scan**

Lower and upper parameter values were collected from the corresponding source. n, m, r, and s are empirical parameters used in the OnGuard model for calculating guard cell osmolarity (see Methods). For more details of selection see Supplemental Code. GC, Guard cell; PS, Photosynthetic; MC, Mesophyll cell.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Lower** | **Upper** | **Units** | **Source Lower** | **Source Upper** |
| *P*abs | 0.81 | 0.99 | Dimensionless | 90% of [(Zhu et al., 2010)](https://paperpile.com/c/IW5K2R/2INz) | 110% of [(Zhu et al., 2010)](https://paperpile.com/c/IW5K2R/2INz) |
| *T*l | 1.7 x 10-4 | 2.4 x 10-4 | m | [(Wuyts et al., 2010)](https://paperpile.com/c/IW5K2R/kShU) | [(Ramonell et al., 2001)](https://paperpile.com/c/IW5K2R/N1UR) |
| *A*l | 1 | 1 | m2 | Fixed | Fixed |
| *V*gc | 4.75 x 10-13 | 4.1 x 10-12 | dm3 | [(Jezek and Blatt, 2017)](https://paperpile.com/c/IW5K2R/oLKz) | [(Hills et al., 2012)](https://paperpile.com/c/IW5K2R/vJTh) |
| *F*q*F*m | 0.79 | 0.9 | Dimensionless | [(Lawson et al., 2003)](https://paperpile.com/c/IW5K2R/TvnR) | [(Lawson et al., 2003)](https://paperpile.com/c/IW5K2R/TvnR) |
| *R*ch | 0.035 | 0.183 | Dimensionless | [(Fujiwara et al., 2019)](https://paperpile.com/c/IW5K2R/V65d) | [(Fujiwara et al., 2019)](https://paperpile.com/c/IW5K2R/V65d) |
| Lair | 0.185 | 0.37 | Dimensionless | [(Ramonell et al., 2001)](https://paperpile.com/c/IW5K2R/N1UR) | [(Earles et al., 2018)](https://paperpile.com/c/IW5K2R/UvsX) |
| *L*epidermis | 0.1 | 0.24 | Dimensionless | [(Willmer and Fricker, 1996)](https://paperpile.com/c/IW5K2R/tBoo) | [(Ramonell et al., 2001)](https://paperpile.com/c/IW5K2R/N1UR) |
| *Vac*frac | 0.751 | 0.9 | Dimensionless | [(Wang et al., 2017)](https://paperpile.com/c/IW5K2R/tZOU) | [(Andrés et al., 2014)](https://paperpile.com/c/IW5K2R/tuWT) |
| *T* | 283.15 | 298.15 | K | 10C | 25C |
| *R* | 0.08205 | 0.08205 | dm3·atm·K−1·mol−1 | Tiesinga et al. (2019) | Tiesinga et al. (2019) |
| *N*gcs | 1.72 x 108 | 11.6 x 108 | m-2 | [(Willmer and Fricker, 1996)](https://paperpile.com/c/IW5K2R/tBoo) | [(Papanatsiou et al., 2016)](https://paperpile.com/c/IW5K2R/JWv0) |
| *n* | 1.5 | 2.5 | atm | Wang et al. (2012) | [(Wang et al., 2017)](https://paperpile.com/c/IW5K2R/tZOU) |
| *m* | 0.8 | 1 | atm·µm-1 | [(Wang et al., 2017)](https://paperpile.com/c/IW5K2R/tZOU) | Wang et al. (2012) |
| *r* | 5 x 10-14 | 8 x 10-14 | dm3·µm-1 | [(Wang et al., 2017)](https://paperpile.com/c/IW5K2R/tZOU) | Wang et al. (2012) |
| *s* | 1 x 10-13 | 3 x 10-13 | dm3 | Wang et al. (2012) | [(Wang et al., 2017)](https://paperpile.com/c/IW5K2R/tZOU) |
| *C*apo | 0.0230 | 37.3 | mol·dm-3 | [(Wang et al., 2017)](https://paperpile.com/c/IW5K2R/tZOU) | [(Roelfsema and Hedrich, 2002)](https://paperpile.com/c/IW5K2R/nId8) |
| *A*closed | 1 | 4 | µm | [(Jezek and Blatt, 2017)](https://paperpile.com/c/IW5K2R/oLKz) | [(Wang et al., 2017)](https://paperpile.com/c/IW5K2R/tZOU) |
| *A*open | 2.75 | 12 | µm | [(Horrer et al., 2016)](https://paperpile.com/c/IW5K2R/IqY5) | [(Wang et al., 2017)](https://paperpile.com/c/IW5K2R/tZOU) |
| ATPase | 0 | 17 | fmol·GC-1·h-1 | 0 | [(Flütsch et al., 2020b)](https://paperpile.com/c/IW5K2R/nMcE) |