E-photosynthesis.org

Web-based platform for photosynthetic processes

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Abstract

E-PHOTOSYNTHESIS framework [3] is a web-based platform for modeling and analysis of photosynthetic processes which provides easy and intuitive navigation through the structure of photosynthetic organisms and aims on being intelligible for students and also experts in the field of system biology.

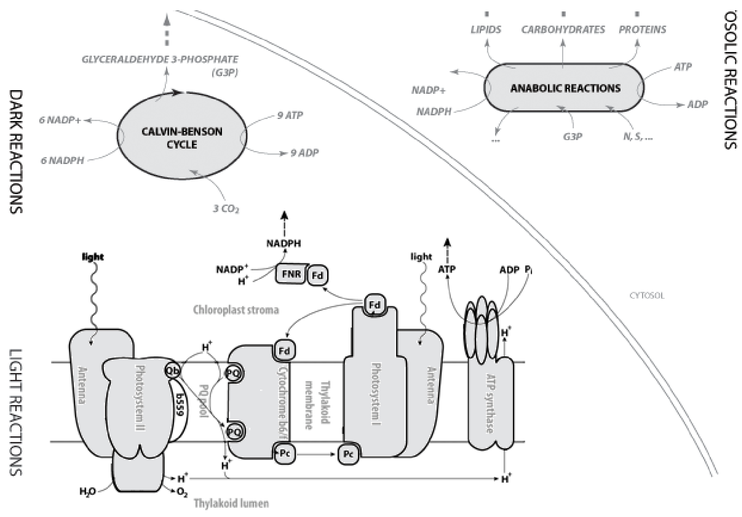
1. Background

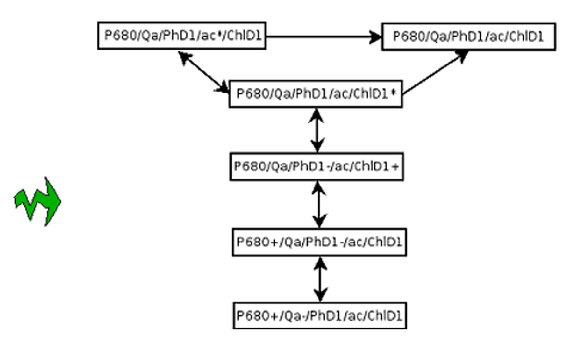
THE tool focuses on providing a platform for international sharing of *kinetic models of photosynthetic processes*. In contrast to existing tools such as *Biomodels.net* [2] (with *JWS Online*) which provide general repositories for biological models, the e-photosynthesis tool is directly focused on photosynthetic organisms. Since existing annotation databases have insufficient coverage of terms related to photosynthetic components and processes, e-photosynthesis is supplied with a *local annotation ontology*. Moreover, photosynthesis contains processes which are usually described by means of combinatorial redox states while this functionality is not contained in available online tools. E-photosynthesis.org covers all features needed to deploy existing kinetic models of photosynthesis *online* and to make them *available* world wide.

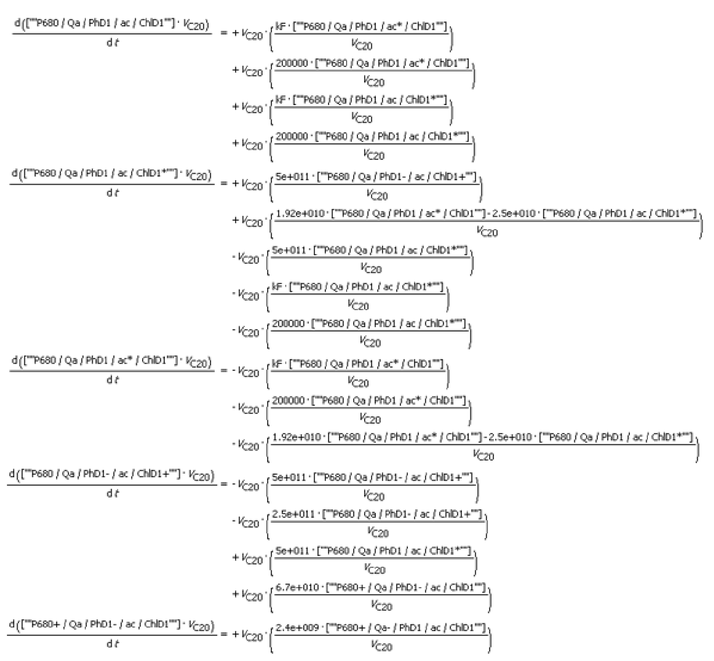
2. E-photosynthesis Tool Description

CURRENT version available at (http://www.e-photosynthesis.org/) includes functions:

- Model representation (hierarchical organization of model components, ODEs, annotation)
- Simulation of provided models
- Custom simulation profiles (initial conditions and parameter sets)
- Model export to *Systems Biology Markup Language (SBML)* [1] and Octave
- Simulation data export to XLS, CSV







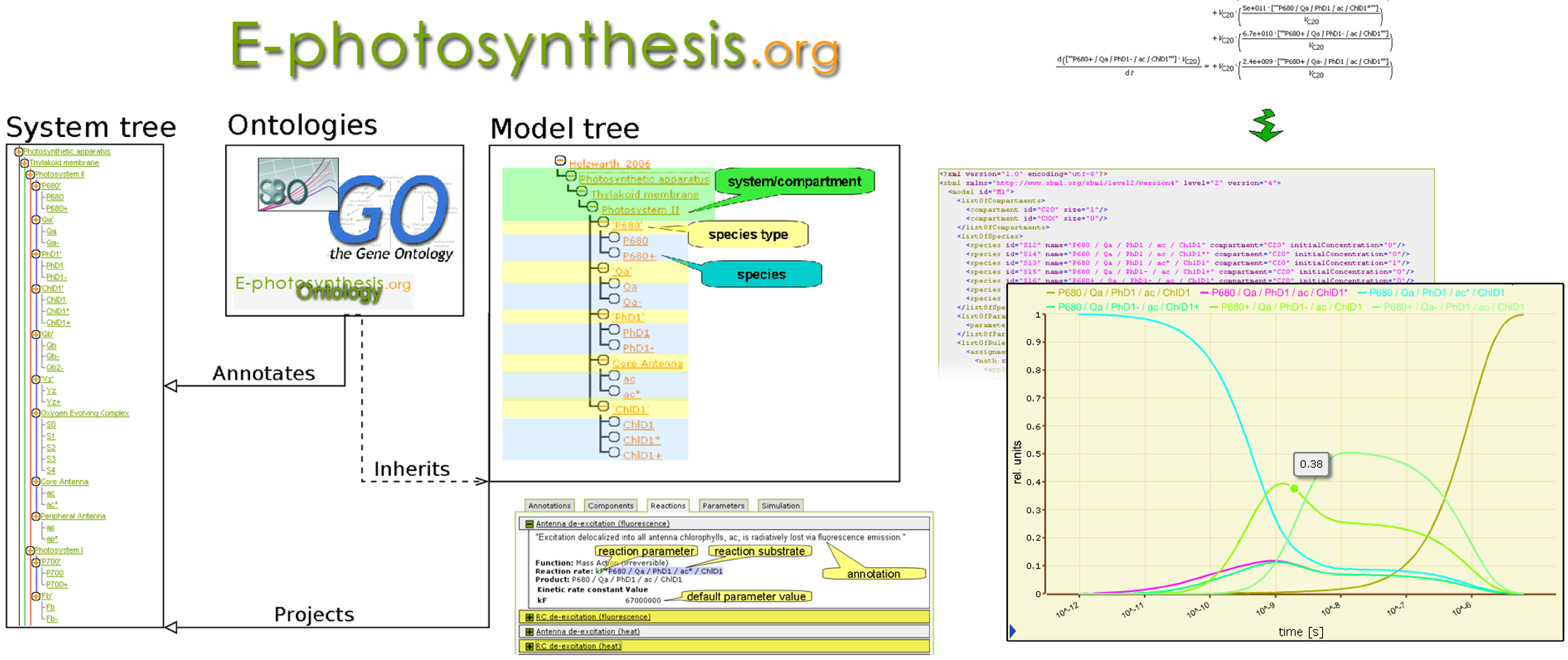
$$\frac{d([\text{""P680 / Qa / PhD1 / ac / ChlD1""}]\cdot V_{C20})}{dt} = +V_{C20}\cdot\left(\frac{kF\cdot[\text{""P680 / Qa / PhD1 / ac* / ChlD1""}]}{V_{C20}}\right) + V_{C20}\cdot\left(\frac{200000\cdot[\text{""P680 / Qa / PhD1 / ac* / ChlD1""}]}{V_{C20}}\right) + V_{C20}\cdot\left(\frac{kF\cdot[\text{""P680 / Qa / PhD1 / ac / ChlD1*""}]}{V_{C20}}\right) + V_{C20}\cdot\left(\frac{200000\cdot[\text{""P680 / Qa / PhD1 / ac / ChlD1*""}]}{V_{C20}}\right)$$

$$\frac{d([\text{""P680 / Qa / PhD1 / ac / ChlD1*""}]\cdot V_{C20})}{dt} = +V_{C20}\cdot\left(\frac{5e{+}011\cdot[\text{""P680 / Qa / PhD1- / ac / ChlD1+""}]}{V_{C20}}\right) + V_{C20}\cdot\left(\frac{1.92e{+}010\cdot[\text{""P680 / Qa / PhD1 / ac* / ChlD1""}]-2.5e{+}010\cdot[\text{""P680 / Qa / PhD1 / ac / ChlD1*""}]}{V_{C20}}\right) - V_{C20}\cdot\left(\frac{5e{+}011\cdot[\text{""P680 / Qa / PhD1 / ac / ChlD1*""}]}{V_{C20}}\right) - V_{C20}\cdot\left(\frac{kF\cdot[\text{""P680 / Qa / PhD1 / ac / ChlD1*""}]}{V_{C20}}\right) - V_{C20}\cdot\left(\frac{200000\cdot[\text{""P680 / Qa / PhD1 / ac / ChlD1*""}]}{V_{C20}}\right)$$

$$\frac{d([\text{""P680 / Qa / PhD1 / ac* / ChlD1""}]\cdot V_{C20})}{dt} = -V_{C20}\cdot\left(\frac{kF\cdot[\text{""P680 / Qa / PhD1 / ac* / ChlD1""}]}{V_{C20}}\right) - V_{C20}\cdot\left(\frac{200000\cdot[\text{""P680 / Qa / PhD1 / ac* / ChlD1""}]}{V_{C20}}\right) - V_{C20}\cdot\left(\frac{1.92e{+}010\cdot[\text{""P680 / Qa / PhD1 / ac* / ChlD1""}]-2.5e{+}010\cdot[\text{""P680 / Qa / PhD1 / ac / ChlD1*""}]}{V_{C20}}\right)$$

$$\frac{d([\text{""P680 / Qa / PhD1- / ac / ChlD1+""}]\cdot V_{C20})}{dt} = -V_{C20}\cdot\left(\frac{5e{+}011\cdot[\text{""P680 / Qa / PhD1- / ac / ChlD1+""}]}{V_{C20}}\right) + V_{C20}\cdot\left(\frac{5e{+}011\cdot[\text{""P680 / Qa / PhD1 / ac / ChlD1*""}]}{V_{C20}}\right) + V_{C20}\cdot\left(\frac{6.7e{+}010\cdot[\text{""P680+ / Qa / PhD1- / ac / ChlD1+""}]}{V_{C20}}\right)$$

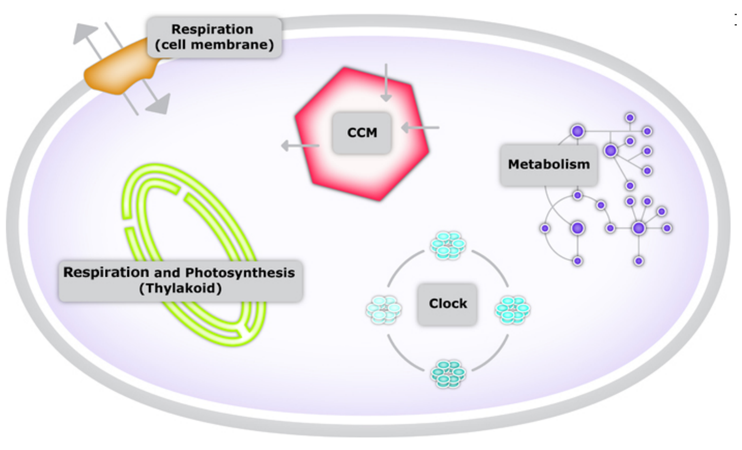
$$\frac{d([\text{""P680+ / Qa / PhD1- / ac / ChlD1+""}]\cdot V_{C20})}{dt} = +V_{C20}\cdot\left(\frac{2.4e{+}009\cdot[\text{""P680+ / Qa- / PhD1 / ac / ChlD1+""}]}{V_{C20}}\right)$$



3. Conclusions and Future work

E-PHOTOSYNTHESIS currently contains annotated models targeting electron transfer in photosystem II, light-induced *chlorophyll a* fluorescence rise, and photosynthesis integrated with carbon/nitrogen metabolism in plants. With this content the tool has been widely used in research and teaching focused on understanding and modeling photosynthesis.

Our work in progress shifts the concept of e-photosynthesis towards a platform particularly focused on integrated modeling of cyanobacteria (the simplest photoautotrophic bacteria).



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References

[1] A. Finney and M. Hucka. Systems biology markup language: Level 2 and beyond. *Biochemical Society Transactions*, 31(pt.6), 2003.

[2] C. Li, M. Donizelli, N. Rodriguez, H. Dharuri, L. Endler, V. Chelliah, L. Li, E. He, A. Henry, M. I. Stefan, J. L. Snoep, M. Hucka, N. Le Novere, and C. Laibe. Biomodels database: An enhanced, curated and annotated resource for published quantitative kinetic models. *BMC Systems Biology*, 4(92), 2010.

[3] D. Šafránek, J. Červený, M. Klement, J. Pospíšilová, L. Brim, D. Lazár, and L. Nedbal. E-photosynthesis: Web-based platform for modeling of complex photosynthetic processes. *Biosystems*, 103(2):115–124, 2011.