

Exploring Thylakoid Emergence: Evolution of Membrane Biogenesis and Photosystem II assembly in early-diverging Cyanobacteria

Louise Hambücken¹, Denis Baurain¹ and Luc Cornet¹

Published in *New Phytologist* (2026)

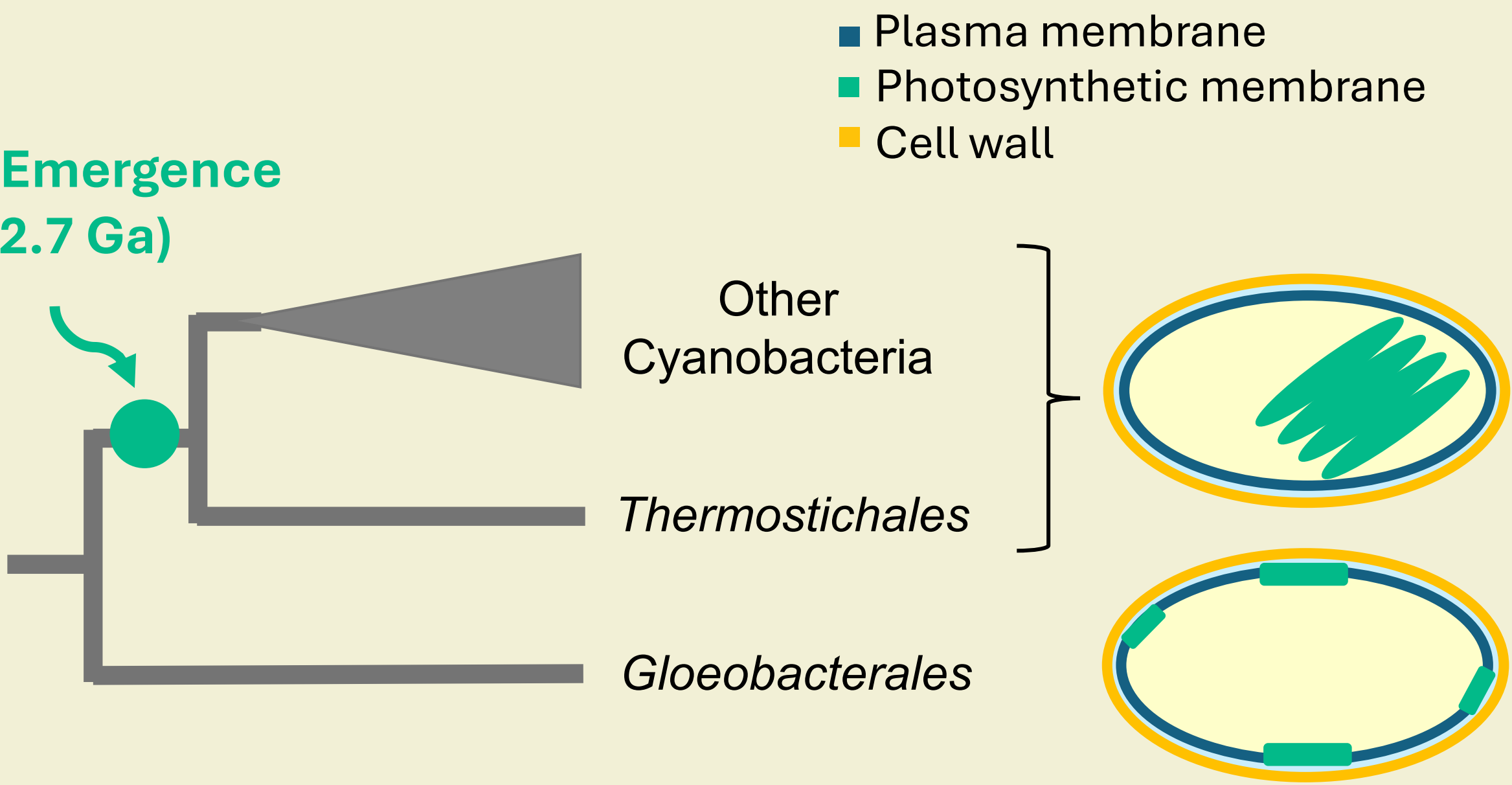
¹InBioS–PhytoSYSTEMS, Eukaryotic Phylogenomics, University of Liège, 4000 Liège, Belgium



Emergence of Thylakoids in Cyanobacteria

- The **emergence of thylakoids** in cyanobacteria (~2.0–2.7 Ga ago) was a major evolutionary innovation that likely contributed to the **Great Oxidation Event** around 2.4 Ga.
- The earliest-diverging cyanobacteria, the *Gloeobacterales*, lack thylakoids and perform photosynthesis in **specialized regions** of the **plasma membrane**.
- This raises a fundamental **evolutionary question**: How photosynthetic machinery was **relocated** from the **plasma membrane** to **thylakoid membranes** during evolution?

Thylakoid Emergence (~2.0-2.7 Ga)



What evolutionary changes in photosystem II assembly and membrane dynamics explain the relocation of the photosynthetic apparatus ?

Dataset Selection
Curation of **950 Terrabacterial genomes** to sample a broad phylogenetic diversity of high-quality genomes from the GTDB and NCBI databases.

Orthology Inference
Identification of **orthologous groups** to track protein evolution across Cyanobacteria.

Phylogenetic Reconstruction
Construction of **Maximum Likelihood trees** to analyze the **taxonomic distribution** and **evolutionary history** of 36 proteins involved in photosystem II assembly and 13 proteins involved in membrane dynamics

Molecular Modeling structures
Multiple sequence alignment and **3D structure prediction** (AlphaFold) to assess functional conservation and identify **key structural motifs**.

