Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36062

Polyphosphate dynamics across trophic modes in *Chlamydomonas reinhardtii*

RONGMAN YAN, XINGYU YANG, QUN MA, JIYING LI AND QIONG ZHANG

The Hong Kong University of Science and Technology

Phosphorus (P) directly regulates microbial metabolism and primary production in aquatic ecosystems. Microorganisms strategically allocate this essential nutrient between core cellular functions and storage as polyphosphate (polyP), a polymer that buffers energy and P supply. While polyP serves remarkably diverse roles in cellular metabolism and survival, how polyP accumulation strategies differ across trophic modes remain unclear. Using the model organism *Chlamydomonas reinhardtii,* we investigated how carbon source shapes P allocation and intracellular polyP dynamics. Integrating physiological growth data with transcriptomic analyses, we found that trophic mode determines cellular energy status, which in turn governs both P utilization efficiency and polyP accumulation. Mixotrophs exhibited the highest efficiency in P uptake and polyP storage, whereas heterotrophs were the least efficient. Transcriptomic profiling traced this difference to energy-production pathways. In mixotrophs, abundant ATP from both photosynthesis and organic carbon oxidation fueled polyP synthesis, via the VTC4 complex, which buffers excess energy. Heterotrophs, relying solely on organic carbon, yielded lower energy efficiency and slower growth rates, constraining polyP accumulation. Furthermore, heterotrophs also upregulated P-related metabolic pathways, suggesting they prioritise P toward immediate energy needs and basal metabolic activities over polyP accumulation. Overall, our findings demonstrate that polyP dynamics are regulated by energy-dependent phosphorus metabolic pathways governed by trophic mode. Consequently, environmental factors that affect microbial energy production, such as light availability and organic carbon sources, will directly influence intracellular P allocation and polyP accumulation, ultimately feeding back into the broader environmental P cycle.