**Orchestral manoeuvres in the light: crosstalk needed for regulation of the Chlamydomonas carbon concentration mechanism**

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**Abstract** The inducible carbon concentration mechanism (CCM) in *Chlamydomonas reinhardtii* has been well defined from a molecular and ultrastructural perspective. Inorganic carbon transport proteins, and strategically located carbonic anhydrases deliver CO2 within the chloroplast pyrenoid matrix where Rubisco is packaged. However, there is little understanding of the fundamental signalling and sensing processes leading to CCM induction. While external CO2 limitation has been believed to be the primary cue, the coupling between energetic supply and inorganic carbon demand through regulatory feedback from light harvesting and photorespiration signals could provide the original CCM trigger. Key questions regarding the integration of these processes are addressed in this review. We consider how the chloroplast functions as a crucible for photosynthesis, importing and integrating nuclear-encoded components from the cytoplasm, and sending retrograde signals to the nucleus to regulate CCM induction. We hypothesize that induction of the CCM is associated with retrograde signals associated with photorespiration and/or light stress. We have also examined the significance of common evolutionary pressures for origins of two co-regulated processes, namely the CCM and photorespiration, in addition to identifying genes of interest involved in transcription, protein folding, and regulatory processes which are needed to fully understand the processes leading to CCM induction.

**Keywords:** Chaperones, Chlamydomonas, CIA5, photorespiration, photosynthesis,

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**Introduction**

The carbon concentration mechanism (CCM) traits found in algae (and cyanobacteria) have evolved to improve the operating efficiency of Rubisco, which is normally packaged within a specific microcompartment: in algae, this is the chloroplast pyrenoid. Inorganic carbon, in the form of bicarbonate, is delivered to the chloroplast stroma using a series of membrane transporters. Saturating internal CO2 concentrations (Ci), ~40× above ambient (Brueggeman *et al*., 2012; Armbruster *et al*., 2013; Atkinson *et al*., 2016), are generated within the pyrenoid by strategically placed transporters of inorganic carbon and carbonic anhydrases (CAs) (Becker 2013; Bauwe *et al*., 2012). The availability of a sequenced genome (Badger *et al*., 1980;), transcriptomic studies for synchronized cells across 24 h light/dark cycles and extensive mutant libraries (Brueggeman *et al.,* 2012) for Chlamydomonas have provided additional opportunities for CCM characterization. ...............................................

**Subtitle 2**

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**Conclusions and future prospects**

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**Conflict of Interest**

Authors have declared that no competing interests exist.

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