Chlorophyll biosynthesis and arginine accumulation are competing processes, regulated by the Gun4 - ArgD couple

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The growth of all living organisms is dependent on nitrogen. Dinitrogen is the most abundant uncombined element on Earth; however, its utilization is limited and most of the organisms rely on the unstable availability of combined nitrogen sources. Cyanobacteria and plants therefore developed sophisticated metabolic routes to balance their nitrogen homeostasis. When nitrogen is abundant oxygenic phototrophs synthetize higher amounts of the α-amino acid arginine that serves as temporary N storage. When scarce availability of N limits the growth, N can be released from the Arg storage and used for protein synthesis and cellular development.

A general observation is that when Arg intensively accumulates, the amount of chlorophyll concomitantly decreases. But how Arg and chlorophyll biosynthesis could be connected remains unknown. We found that ornithine, an intermediate metabolite of Arg biosynthesis suppressed chlorophyll production in *Synechocystis* sp. PCC 6803. Orn primarily inhibited the formation of Mg-protophorphyrin IX, the first committed precursor of chlorophyll. This process requires the Gun4 protein interacting with magnesium chelatase in the photosynthetic membranes. However, a substantial amount of Gun4 was located in the cytosol, forming a soluble complex with the ArgD enzyme participating in the biosynthesis of Orn. Assembly of the Gun4-ArgD complex was triggered by Orn, and simultaneously obstructed the synthesis of chlorophyll.