ALGAL PYRENOID

BY

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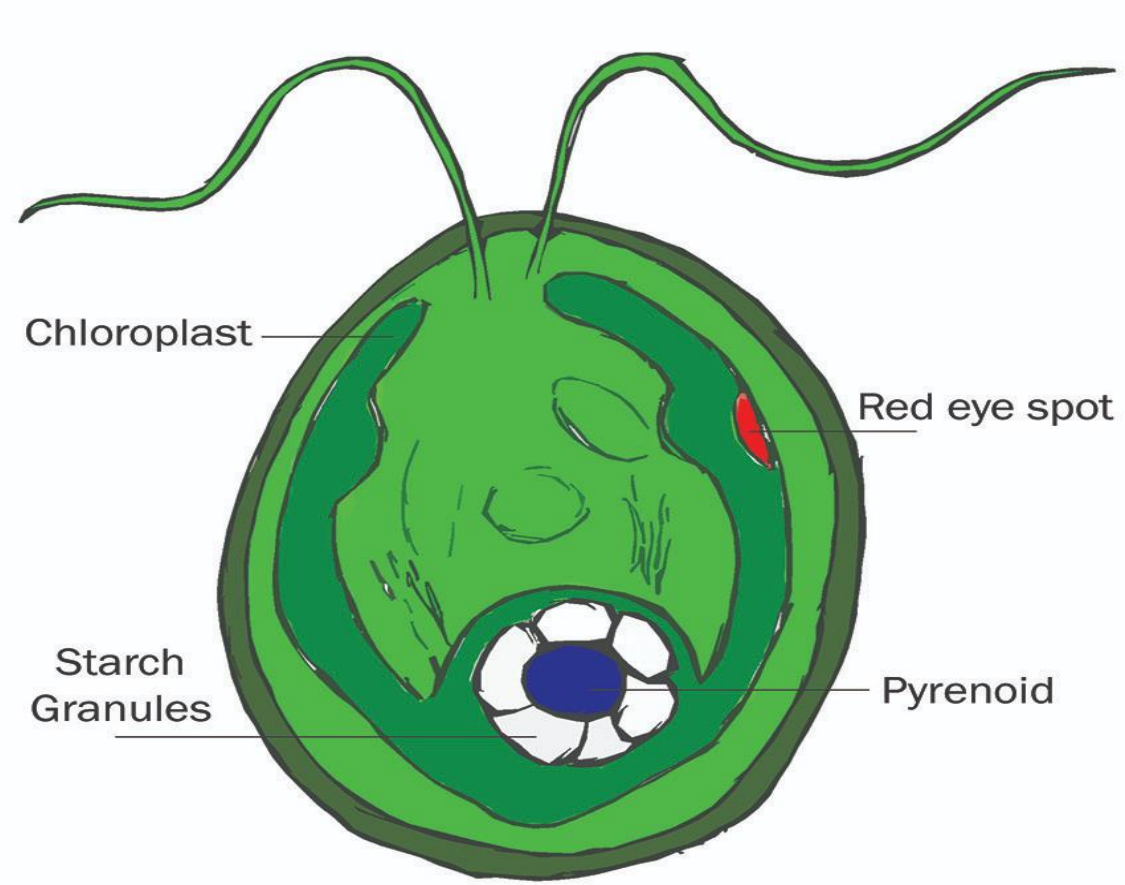
- Pyrenoids are sub-cellular micro-compartments found in chloroplasts of many algae
- Their main function is to act as centres of carbon dioxide (CO2) fixation, by generating and maintaining a CO2 rich environment around the photosynthetic enzyme ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO)
- Pyrenoids therefore seem to have a role analogous to that of carboxysomes in cyanobacteria

- There is substantial diversity in pyrenoid morphology and ultrastructure between algal species
- The common feature of all pyrenoids is a spheroidal matrix, composed primarily of RuBisCO
- In most pyrenoid-containing organisms, the pyrenoid matrix is traversed by thylakoid membranes, which are in continuity with stromal thylakoids

- In the unicellular red alga Porphyridium purpureum, individual thylakoid membranes appear to traverse the pyrenoid

- In the green alga Chlamydomonas reinhardtii, multiple thylakoids merge at the periphery of the pyrenoid to form larger tubules that traverse the matrix
- A starch sheath is often formed or deposited at the periphery of pyrenoids, even when that starch is synthesised in the cytosol rather than in the chloroplast



- The pyrenoid is a region of the chloroplast containing a characteristic dense matrix material
- Variations were observed in the nature of the lamellar structures which penetrate the pyrenoid region
- In the Rhodophyta, the pyrenoid is traversed by single discs. In the Euglenophyta, two-disc bands cross the pyrenoid
- In the pyrenoids of the Chrysophyta, a variety of lamellar structures are present
- In the one species of Pyrrophyta studied, the pyrenoid is traversed by three-disc bands
- Lamellar structures are absent in the bridge pyrenoid of the Cryptophyta and the stalked pyrenoid of the Phaeophyta

- When examined with transmission electron microscopy, the pyrenoid matrix appears as a roughly circular electron dense granular structure within the chloroplast
- Early studies suggested that RuBisCO is arranged in crystalline arrays in the pyrenoids of the diatom Achnanthes brevipes

- Recent work has shown that RuBisCO in the pyrenoid matrix of the green alga Chlamydomonas is not in a crystalline lattice

- In Chlamydomonas, a high-molecular weight complex of two proteins forms an additional concentric layer around the pyrenoid, outside the starch sheath, and this is currently hypothesised to act as a barrier to CO2-leakage or to recapture CO2 that escapes from the pyrenoid

- In Porphyridium and in Chlamydomonas, there is a single highly conspicuous pyrenoid in a single chloroplast, visible using light microscopy

- By contrast, in diatoms and dinoflagellates, there can be multiple pyrenoids

- The Chlamydomonas pyrenoid has been observed to divide by fission during chloroplast division

- Pyrenoids partially dissolved into the chloroplast stroma during every cell division, and this pool of dissolved components may condense into a new pyrenoid

THANK YOU