HOW CYANOBACTRIA MANAGED TO SURVIVE UNDER INTENSE SOLAR RADIATION BILLIONS YEARS AGO: PHOTOPROTECTION MECHANISMS

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Sun light involved in the abiogenous synthesis of complex organic molecules on the earliest steps of chemical evolution, became dangerous for life because of high UV and VIS light penetration on the Earth at the absence of ozone layer. On the earliest steps of biological evolution the protection of primitive heterotrophs and phototrophs was carried out with contribution of various mechanisms. Photosynthesis triggered by Solar light is the main process that supports life on the Earth supplying the biosphere by oxygen and organic compounds. However the intense Sun irradiation is especially dangerous for photosynthesis. Different photoprotection mechanisms are involved in dissipation of excess energy absorbed by light-harvesting complex to prevent the photosynthetic apparatus against photodestruction.

We have found two photoprotective mechanisms of the photosynthetic apparatus of cyanobacteria that lead to dissipation of excess energy absorbed by light-harvesting antenna pigments. One of them deals with non-photochemical quenching of energy absorbed by phycobilisomes, the main light-harvesting antenna in cyanobacteria. The action spectrum of this quenching has revealed that carotenoid is a sensitizer (and quencher) of energy absorbed by phycobilisomes located out of thylakoids. The extra-thylakoid orange carotenoid-binding protein (OCP) in excited state binds to phycobilisomes causing non-photochemical quenching that diverts excitation away from phycobilisomes decreasing the energy flow to photoystems. Another mechanism of energy dissipation in cyanobacteria relates to quenching of excess energy absorbed by photosystem I antenna long-wavelength chlorophylls that function as terminal energy acceptors. Note that the photosystem I monomers and trimers in cyanobacteria contain about 80% of whole chlorophyll. Accumulated at high irradiance, cation radical of P700 quenches efficiently the excited state of the long-wavelength chlorophylls, protecting against photodemage. Both evolutionary oldest photoprotection mechanisms have stimulated the photostability of the photosynthetic apparatus of cyanobacteria.

References

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