ABIOGENIC ALTERNATIVE TO THE CHLOROPHYLL-BASED CONVERTOR OF SOLAR ENERGY

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The conversion of energy from solar light in the biosphere is performed through chlorophyll-based photosynthesis, and there are reasons to believe that photosynthesis began early in Earth's history but was probably not one of the earliest metabolisms. The key event of photosynthesis is the excitation of chlorophyll (or a bacteriochlorophyll) molecule by energy of absorbed photon. The energy available in the electrons transferred from excited pigment is conserved in NAD(P)H, or used to pump protons across the membrane to form the proton gradient which drives the catalytic formation of ATP. Under certain circumstances, i.e. in photosynthetic purple bacteria, ATP is the only product from the photosynthetic conversion of light energy.

Evolution presumes a competition between alternative options to select the fittest. In this context ptreidine derivatives are a possible alternative to chlorophyll, i.e. a Mg-porphyrin, in the development of biological converters of light energy. According to results of chemical modelling, pteridine derivatives - flavins and pterins, could arise on prebiotic Earth from the thermolysis of amino acid mixtures. Excitation strongly increases activity of these molecules in electron transfer and when excited, they sensitize the redox reactions leading to accumulation of free energy in products. In hybrid silicate-organic micro- and nanoparticles formed under simulated prebiotic environment these abiogenic pigments efficiently catalyze phosphorylation of ADP by orthophosphate to form ATP [1,2].

Flavins and pterins are essential cofactors for "dark" enzymatic reactions in all organisms. When excites, they play key roles in several families of photoenzymes and regulatory photoreceptors, and the substantial structural differences between these protein families indicate that biological evolution has repeatedly used flavins as chromophores for photoreceptor proteins. Some of these photoreceptors are equipped with a pteridine light-harvester, which transfers excitation energy to chemically reactive reaction center.

The sum of the available data suggests that evolution could have formed a flavin-based biological converter to convert energy of visible light into energy in the form of ATP [3]. When considering the competitiveness of this converter in the evolution we should bear in mind that flavins and other pteridine derivatives concede to complex of photosynthetic pigments in the ability to utilize light of a wider spectral range, including its red area. This fact is important in an evolutionary context, especially for the environment in which the radiation reaching the surface of the planet is filtered by the atmospheric ozone.

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References

[1] M.P.Kolesnikov, T.A.Telegina, T.A.Lyudnikova, M.S.Kritsky, *OLEB* 2008, **38**, 243.
[2] T.A.Telegina, M.P.Kolesnikov, Y.L.Vechtomova, A.A.Buglak, M.S.Kritsky 2013 *J. Mol. Evol.* **76,** 3.
[3] M.S.Kritsky, T.A.Telegina, Y.L.Vechtomova, A.A.Buglak *Int. J. Mol. Sci.* 2013, *14*, 575.