Novel photoprotection mechanisms in photosynthetic pigment-protein complexes.

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Chlorophylls play a major role in the process of photosynthetic energy conversion, serving as major light harvesting pigments and as electron transfer components in pigment-protein complexes. Surprisingly, monomeric chlorophyll in solution is extremely unstable – it degrades into colorless chemicals within minutes under sunlight illumination. The source of this instability is high quantum yield of the excited triplet state formation that readily transfers energy to a nearby oxygen molecule, generating singlet excited oxygen. The latter is chemically very active and can easily oxidize a chlorophyll molecule or a nearby protein. It has been shown that nature solved the problem of photodegradation by placing a carotenoid molecule within ~4 Å of chlorophyll. Rapid triplet-triplet energy transfer from chlorophyll to carotenoid prevents the formation of singlet oxygen, offering a high level of protection. Recently, our group discovered three novel mechanisms utilized by nature to photoprotect chlorophylls: (i) quenching of the singlet excited state of a chlorophyll via electron transfer exchange, (ii) long distance triplet-triplet energy transfer from chlorophyll to carotenoid and (iii) triplet exciton formation in a strongly coupled chlorophyll system. In this talk, I will describe these novel photoprotection mechanisms.