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Measuring Photosynthesis of Oxygenic and Anoxygenic Photosynthetic Organisms using Pulse Amplitude Modulation (PAM) Fluorometry

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Oxygenic photosynthesis can easily be measured using O_2 or CO_2 gas exchange, oxygen electrodes, Winkler titration and $^{14}CO_2$-fixation and by PAM (Pulse Amplitude Modulation) fluorometry. PAM estimates the photosynthetic electron transport rate (ETR) by measuring fluorescence of chlorophyll (Chl) *a* (> 700 nm) induced by blue (Soret, Q_X) band or red light (Q_Y) band. Photosynthetic rates are much less readily measureable in anoxygenic photosynthesis. Anoxygenic photosynthetic bacteria (APB) do not use water as an electron source and are typically photoheterotrophic rather than photoautotrophic and so $^{14}CO_2$ fixation is a misleading estimate of photosynthetic electron transport in APB photosynthesis. Most use bacteriochlorophyll (BChl) *a* as their primary photosynthetic pigment. *In vivo* BChl *a* has a Soret band very similar to Chl a but its Q_Y bands are in the infrared and fluorescence is at > 800 nm. Blue-diode-based PAM can be used measure the ETR in purple non-sulphur anoxygenic photobacteria, such as *Afifella marina* and *Rhodopsuedomonas palustris* and purple sulphur bacteria such as *Thermochromatium tepidum* because their RC-2 type BChl *a* complexes have variable fluorescence similar to PSII. Conventional blue-diode PAM cannot readily distinguish oxygenic and anoxygenic photosynthesis in situations such as sewage ponds. We describe the development of two new types of PAM machines: one that only measures oxygenic photosynthesis and the other only measures anoxygenic photosynthesis enabling estimations of both photosynthetic activities in environmental samples. Some types of APB have RC-1 type of photosynthesis that cannot be measured using PAM methods.

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