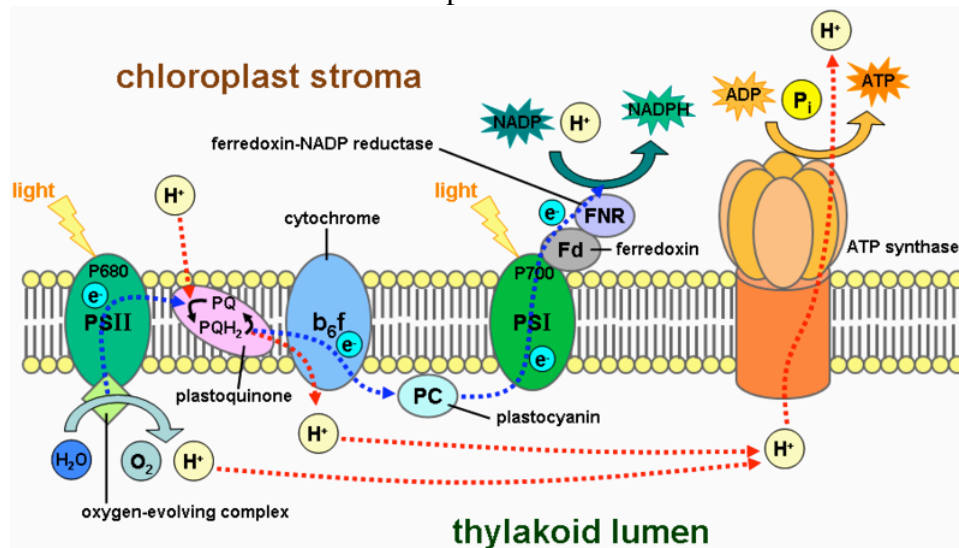


Lecture 9 -- Ch. 5: The biosphere.

1. Photosynthesis – conversion of light energy ($h\nu$) to chemical energy
 - a. Net reaction of oxygenic photosynthesis:
 - i. $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
 2. Actual reaction is much more complicated:



- i. Capture of light by chlorophyll (Mg-bearing pigment), transition to excited chemical state, loss of electron

$$\text{Chl} + h\nu \rightarrow \text{Chl}^+ + e^-$$
 - ii. Transport of electron to NADP^+ , reduction to NADPH
 1. $\text{NADP}^+ + 2e^- + \text{H}^+ \rightarrow \text{NADPH}$

nicotinamide

nicotinamide with extra H
 - iii. Creation of energetic ATP from ADP
 - iv. Chlorophyll re-reduced by splitting water molecules
 1. $\text{H}_2\text{O} \rightarrow 4\text{H}^+ + 4e^- + \text{O}_2$
 2. $\text{Chl}^+ + e^- \rightarrow 4\text{Chl}$
 - v. Stored NADPH, ATP energy used to reduce carbon in CO_2
3. Requirements of oxygenic photosynthesis
 - i. H_2O , CO_2 , sunlight (consumed)
 - ii. phosphate, nitrogen (energy storage)
 - iii. nitrogen, phosphate, magnesium, manganese, calcium, chloride (energy capture and catalysis infrastructure -- enzymes).
 - b. Water/ CO_2 acquisition

- i. Terrestrial plants acquire CO₂ from the atmosphere via diffusion through leaf pores (stomata). However, H₂O is usually unsaturated in air (humidity < 100%), so H₂O diffuses out at the same time CO₂ diffuses in!
 - ii. In NH forest, ~25% of rainfall H₂O re-evaporated through stomata!
 - iii. Under water stress, plants partially close stomates, slowing down photosynthesis
 - iv. Response to rising atmospheric CO₂?
 - c. Nutrient use
 - i. Nitrogen typically limiting, large inventory needed for enzymes. Strong correlation between nitrogen content in leaves and rate of photosynthesis (Fig. 5.3).
- 4. Net primary production
 - a. ~1/2 of captured chemical energy used quickly by plants
 - b. ~1/2 contributes to plant growth, eventually exported or lost to environment
 - c. Net primary productivity == 3(b), chemical energy not respired by maintenance by plants themselves.
 - i. Units: gC/m²/yr
 - ii. Strongly correlated with leaf mass (Fig. 5.5)
 - iii. Typical value in forest ~100-1000 gC/m²/yr
 - d. Determining NPP
 - i. Gravimetry in lab land
 - ii. Remote sensing of leaf area/intensity
 - 1. Chlorophyll absorbs < 760nm, not >800 nm
 - a. Reflects 800nm >> 760nm
 - 2. Soil/rock typically absorb/reflect both ~equally
 - 3. Leaf area should correlate with LANDSAT TM4(850nm)/TM3(680nm) (Fig5.7)
 - 4. Typical global estimate ~6x10¹⁶ gC/yr
 - e. Geography/Weather effects on NPP
 - i. Mean temperature (positive or negative?)
 - ii. Mean precipitation (positive or negative?)
 - iii. Reaction to climate change?