The Basis: Light Absorption Processes

Energy of light: $E = h\nu = h\frac{c}{\lambda}$

speed of light = 2.998×10^8 m/s

frequency

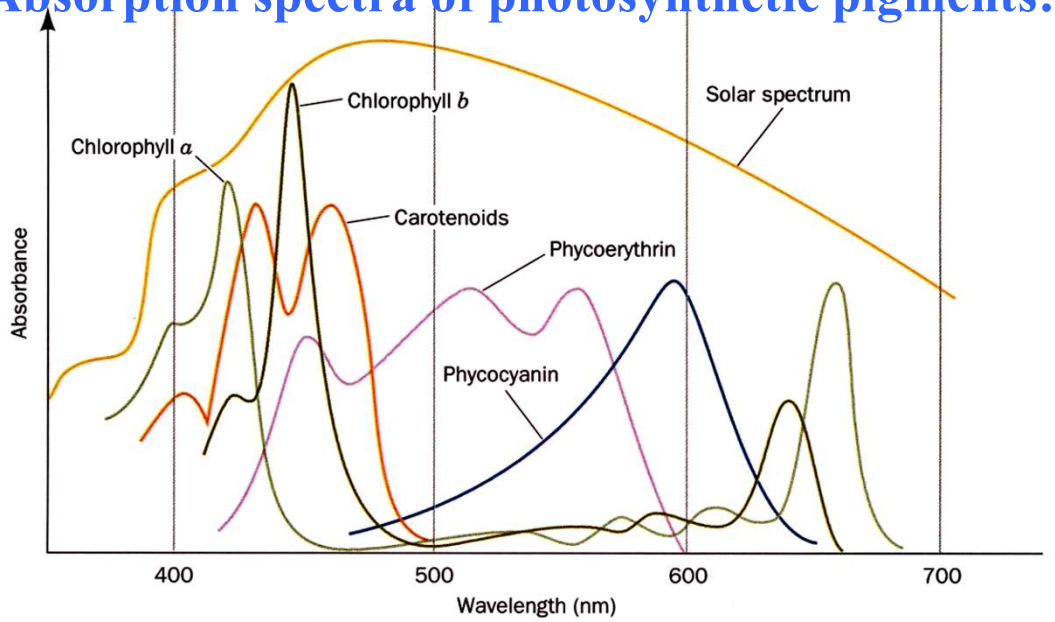
wavelength

Planck's constant = 6.626×10^{-34} Js

$\lambda = 700$ nm $\Rightarrow$ E = 171 kJ/mol

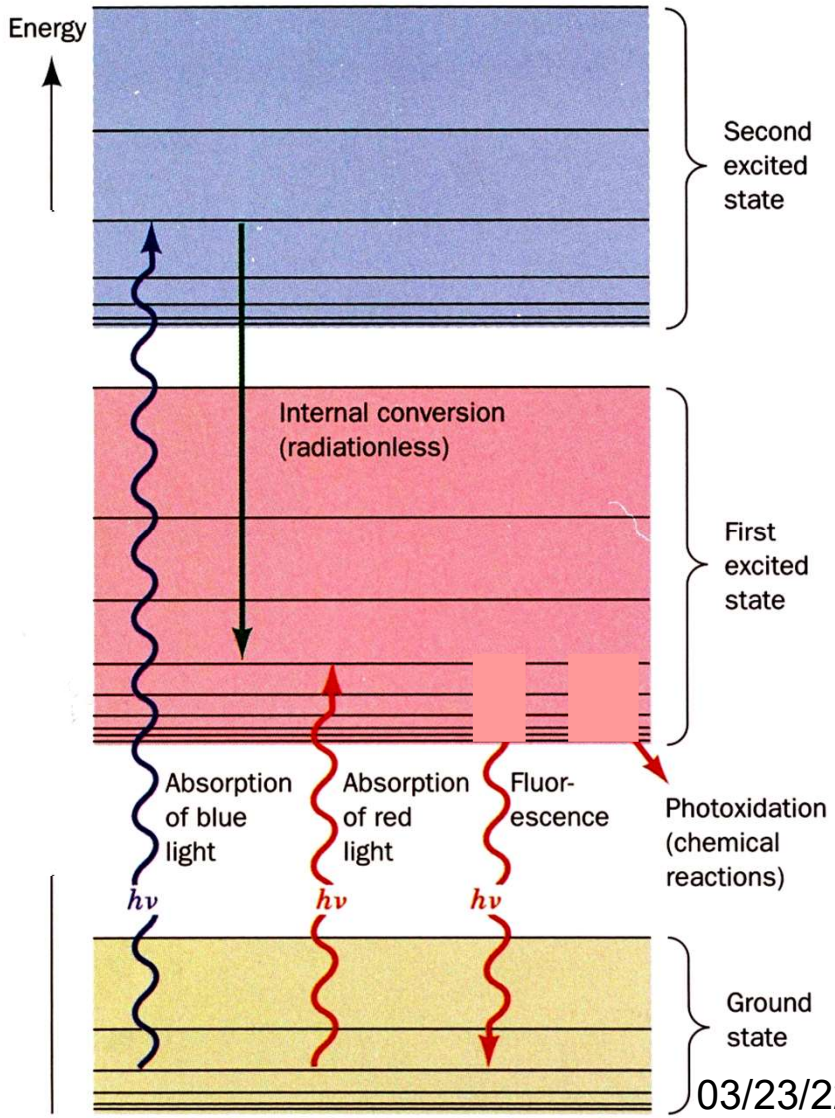
The energies of photons and molecular orbitals are quantized $\Rightarrow$ only matching photons can be absorbed!

Absorption spectra of photosynthetic pigments:

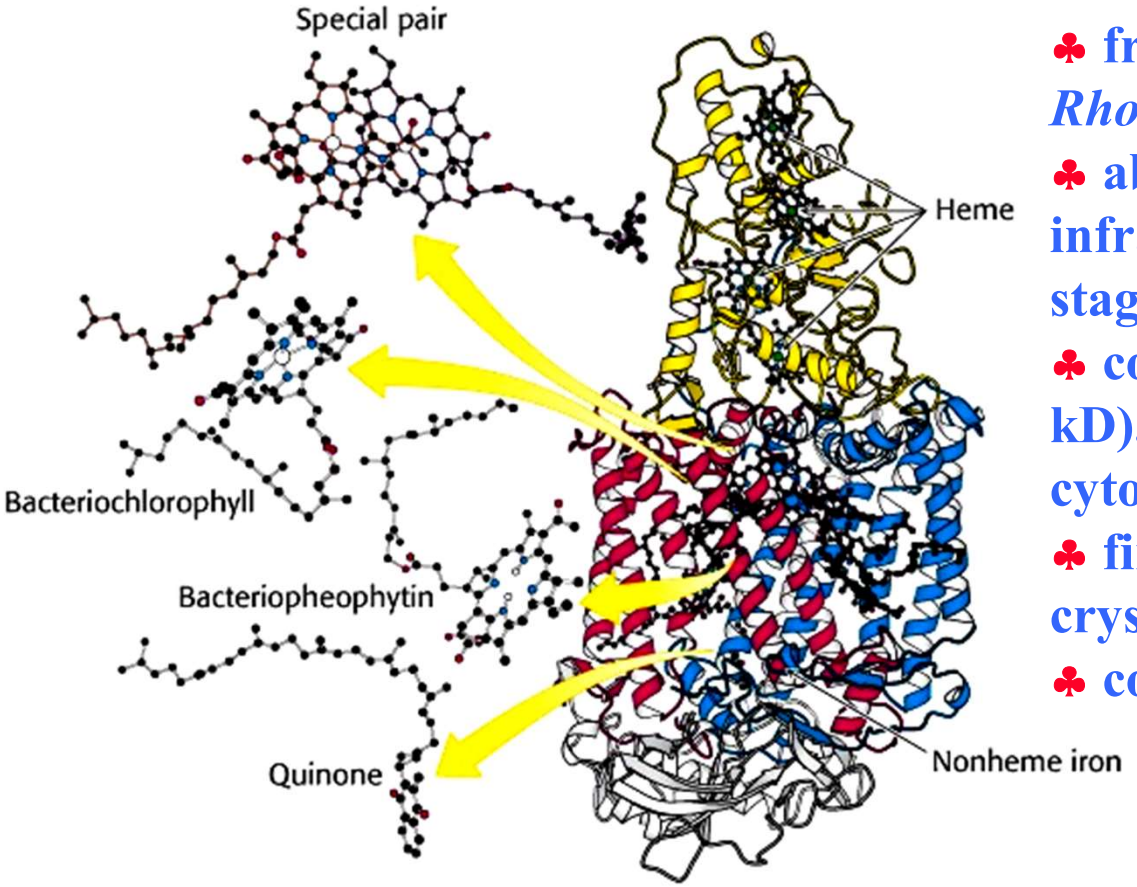


Slight chemical differences modulate the absorption properties of chlorophylls a and b!

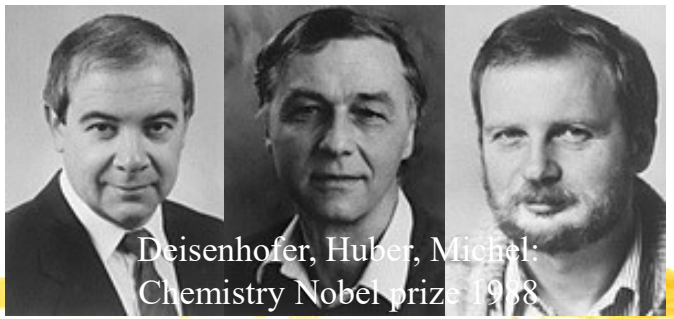
What happens after absorption?



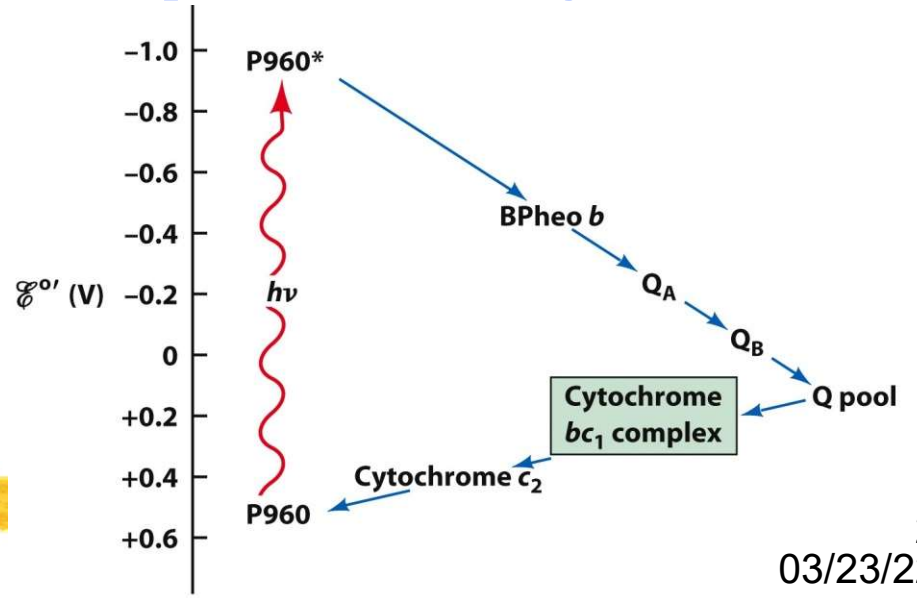
Using Photoenergy: The Bacterial Photosynthetic Reaction Center



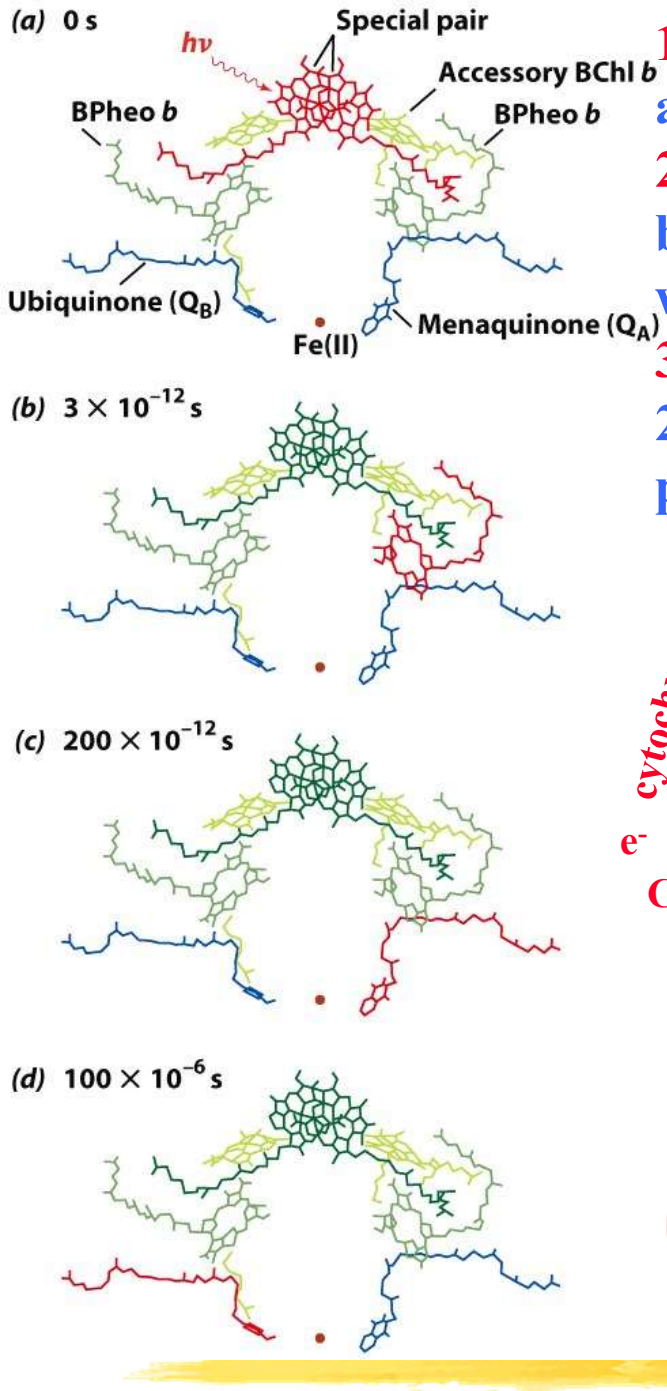
- from purple photosynthetic bacterium *Rhodospirillum rubrum*;
- absorbs around 960 nm (or 870 nm; near-infrared absorption best for habitat in murky stagnant ponds) ⇒ also called complex P960;
- contains 4 polypeptides: subunits L (31 kD), M (36 kD), H (28 kD), and C, a c-type cytochrome with 4 hemes;
- first transmembrane protein ever crystallized;
- converts photons into energetic electrons:



Deisenhofer, Huber, Michel:
Chemistry Nobel prize 1988



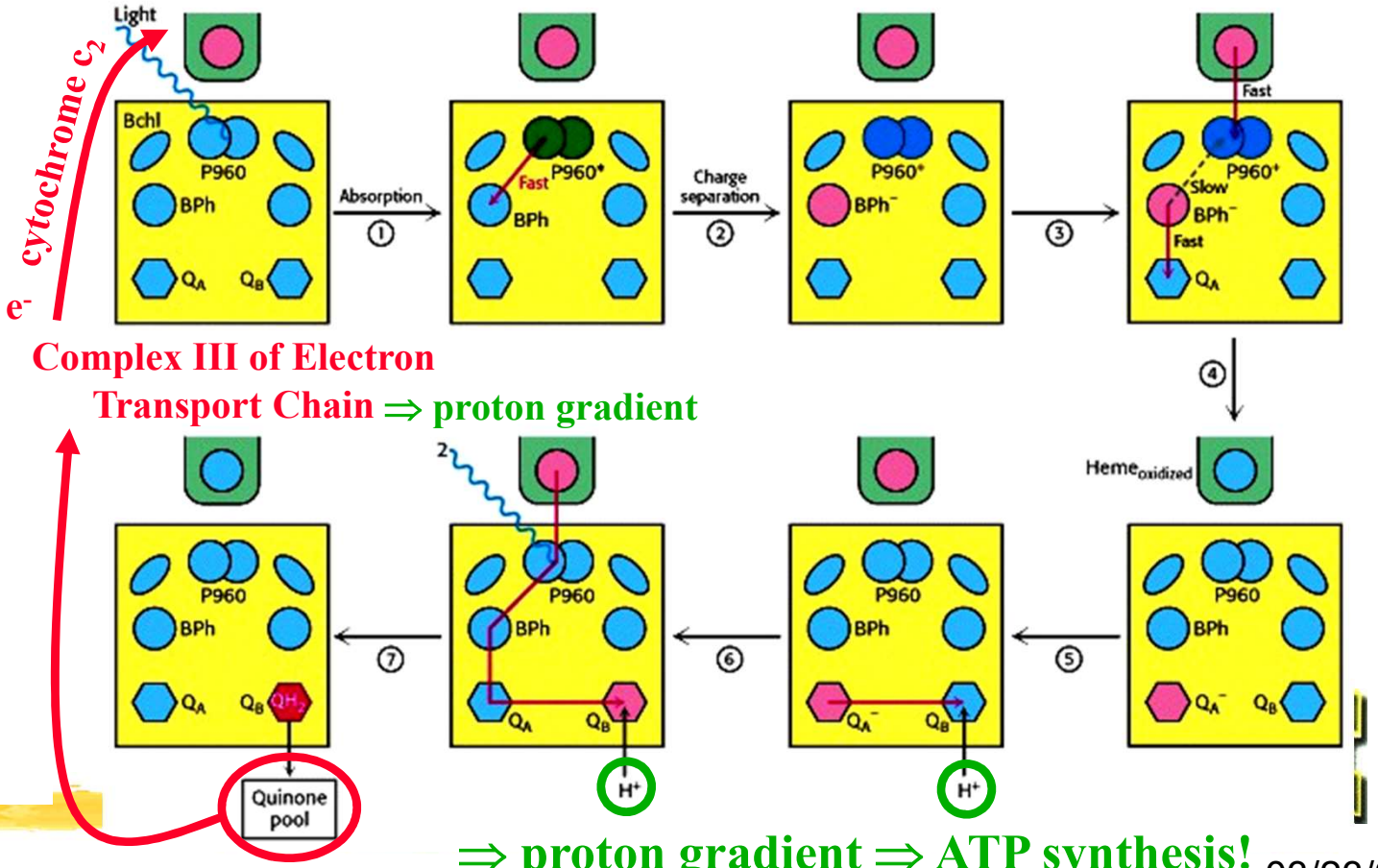
How Does This Work?



1.) P960 (P870), a "special pair" of bacteriochlorophyll b (a), absorbs a photon within 3 fs;

2.) the excited P960* (P870*) loses its electron to bacteriopheophytin (has 2 H^+ instead of Mg^{2+} of chlorophylls) within 3 ps;

3.) electron moves further towards menaquinone Q_A within 200 ps; overall, this process is irreversible because e^- goes to progressively lower energy states!

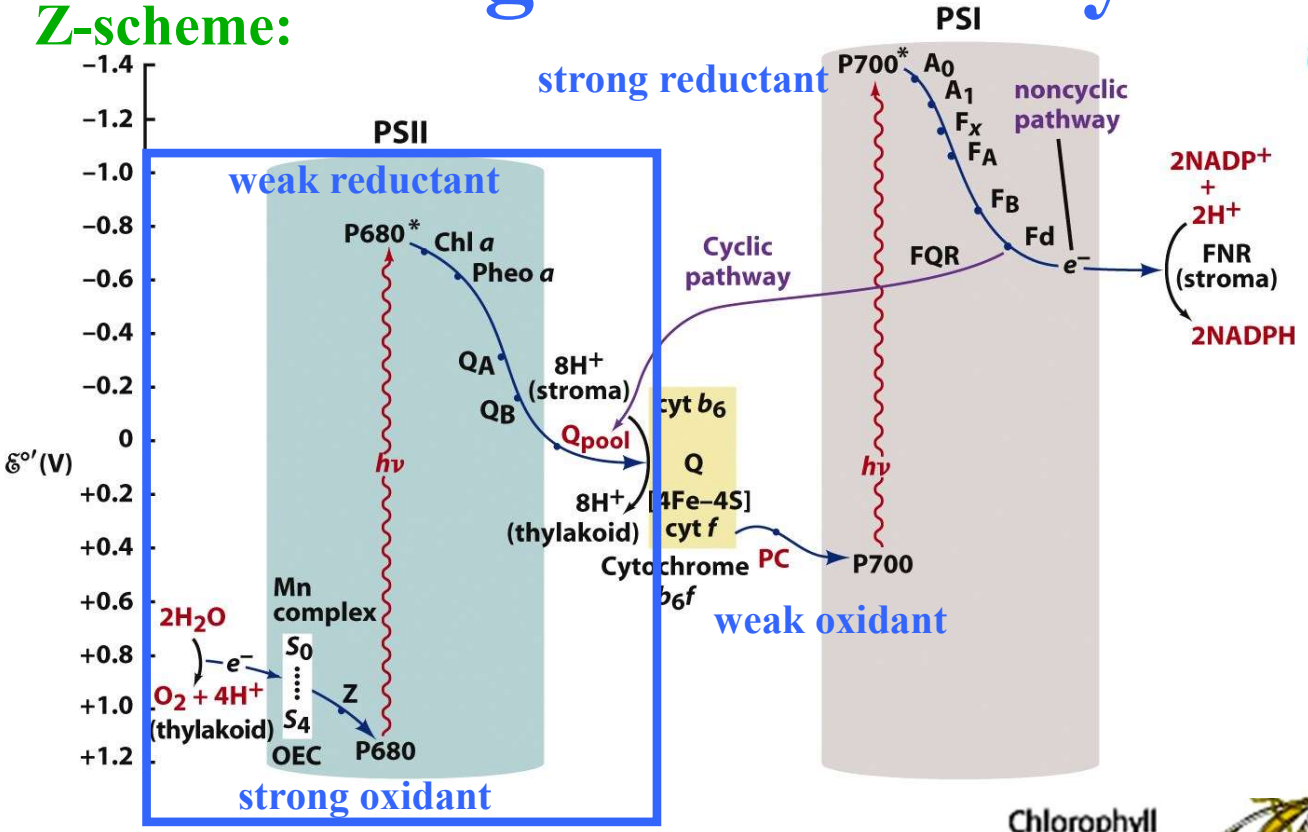


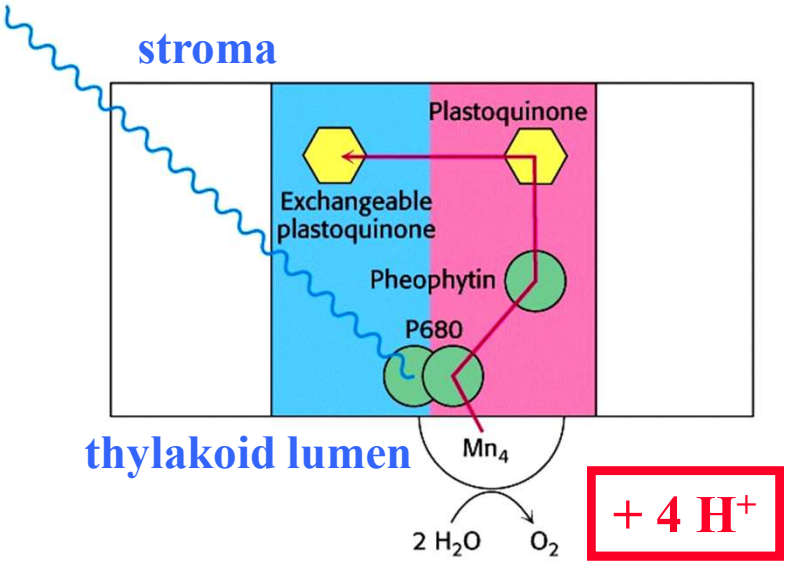
Complex III of Electron Transport Chain ⇒ proton gradient

⇒ proton gradient ⇒ ATP synthesis!

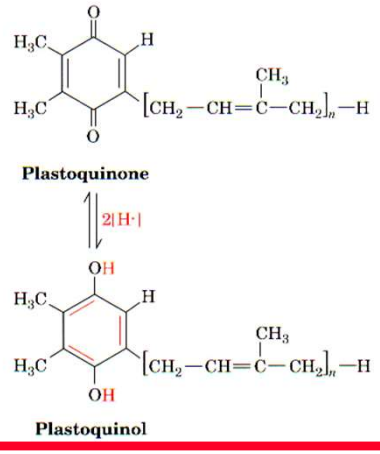
Analogous: Photosystem II of Plants

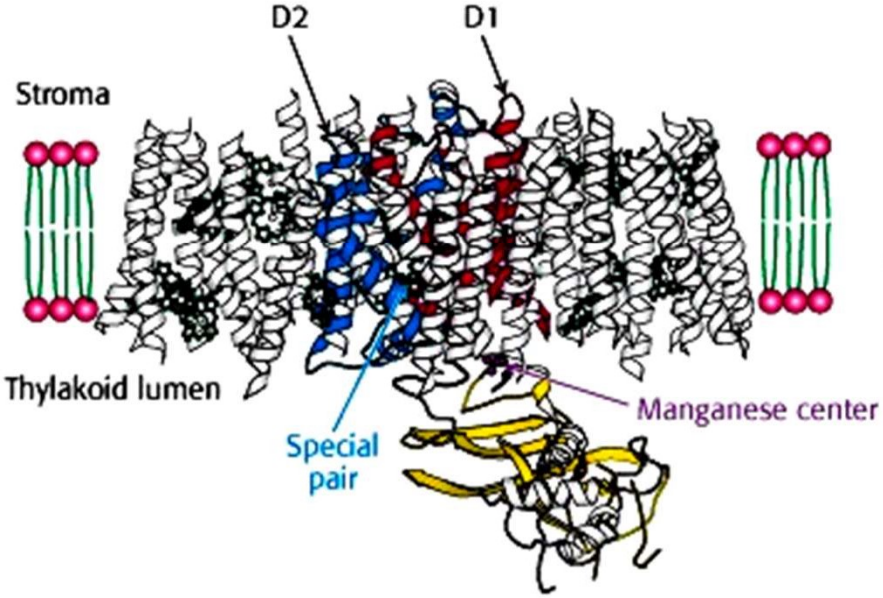
Z-scheme:

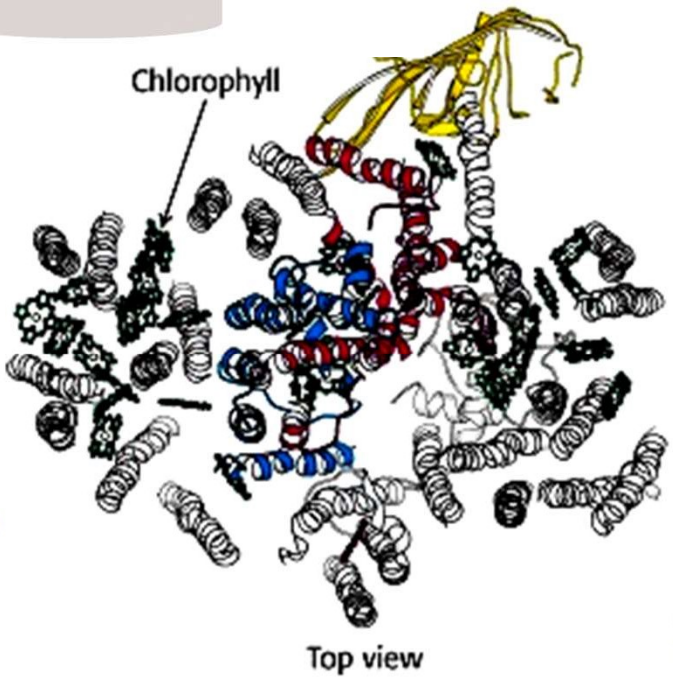




+ 4 H^+







PS II transfers electrons from H_2O to mobile plastoquinone and generates a H^+ gradient

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