

PHOTOSYNTHESIS

INTRODUCTION

11/18/91, rvsd 11/13/95, 11/20/96, 15 Nov 99, 15 Nov 00, 16 Nov 01, 20 Nov 02, 17 Nov 03, 15 Nov 04, 10Nov08, 6Nov09, 8Nov10, 6Nov11
BRP p 374-389, BKH pp 451-469, BKH 5th: 445-474, 6th: 288-315, 7th:

Phototrophs use light as a source of the energy for nourishment

transduction: convert radiant energy into chemical energy.

Can use variety of H (or electron) sources:

Overall photosynthesis rxn:



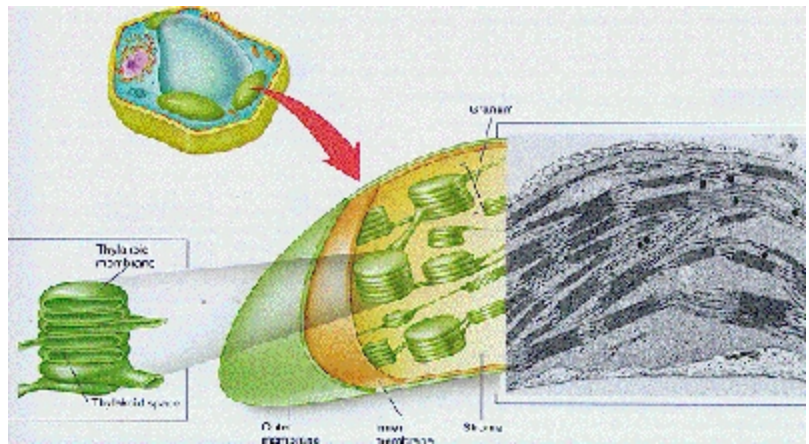
Photosynthesis involves two functional processes: (p 294)

I. LIGHT RXNS: ENERGY TRANSDUCTION:

photophosphorylation & photoreduction: a variety of sources of electrons can be used: H_2O , H_2 , H_2S , or NH_3
(**oxygenic photoautotrophs:** if water is the source)

II. DARK REACTIONS: CARBON ASSIMILATION:

reductive carboxylation. CO_2 is absorbed and reduced to a sugar



CHLOROPLASTS: (p 296) the 'energy transducer,' first seen by Leeuwenhoek

1880 Engelmann noted obligate aerobic O_2 -seeking motile bacteria clustered around chloroplasts in *Spirogyra*, only when illuminated.
Concluded that O_2 was produced during photosynthesis.

Chloroplasts (20-50 per cell) are presumed to have been gained by **endosymbiosis**, as with mitochondria, (p 298)

Structured similarly to mitochondria: they also have their own DNA, translational mechanism (p. 301)

thylakoid discs (sack, pouch-like)

flattened sacs, stacked together to form **grana**

stroma lamellae (anything spread out, coverlet)

membranes which connect grana

MEMBRANES of chloroplasts, highly structured:

outer: like mitochondria, primarily supportive

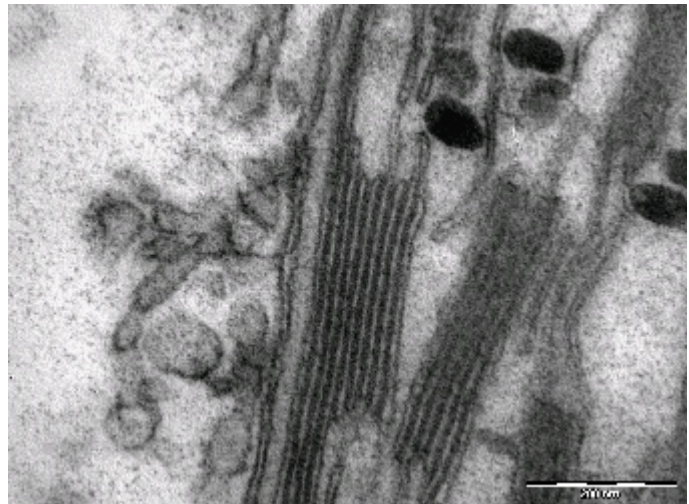
inner: highly structured, complex

MAJOR COMPARTMENTS:

intrathylakoid: pigments, especially chlorophyll (p 295 for "antenna" light harvesting complex) and photosynthetic enzymes

ET carriers coupled to phosphorylation (within the stroma lamellae)

stroma: dark reactions--carbon metabolism (not unlike matrix in mitochondria)



CHLOROPHYLL: (p 300) Porphyrin with Mg.

Absorbs blue-green (420-480 nm) and red (620-680 nm) strongly

Mg has electron activated by light. Porphyrin ring allows multiple levels of excited state, thus absorbs broad range of wavelengths.

Emerson effect:

Supplementing with far red light (700 nm) enhances O_2 evolution

Deduced two energy capture systems: P700 (PS I) and P680 (PS II)

ACCESSORY PIGMENTS: Collect light at other λ , transfer energy by resonance

carotenoids absorb in violet to green (thus look yellow-orange)

phycobilins absorb in green to orange (appear purple)

Light harvesting photosynthetic unit acts as antenna to collect energy:

group of 250-300 antennae chlorophyll molecules, + carotenes

NADP⁺ REDUCTION: Photoreduction occurs in PS I:

- 1) chlorophyll:absorbed photon use to activate electron, passed to
- 2) bound **ferredoxin**, then to
- 3) then a **flavoprotein**
- 4) then to **NADP reductase:** NADP^+ to produce NADPH

