PHOTOSYNTHESIS

INTRODUCTION

11/18/91, rvsl 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, 12Oct12
BRP p 374-389, BKH pp 451-469, BKH 5th: 288-315, 6th: 288-315,
(photic 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 generalized photosynthesis rxn:
\[ \text{CO}_2 + 2\text{H}_2\text{O} \rightarrow [\text{CH}_2\text{O}] + 2\text{A} + \text{H}_2\text{O} \]

Photosynthesis involves two functional processes: (p 294)

I. LIGHT RXNS: ENERGY TRANSDUCTION:
photophosphorylation & photoreduction: a variety of sources of electrons can be used: \( \text{H}_2\text{O}, \text{H}_2, \text{H}_2\text{S}, \text{or NH}_3 \)
(oxygenic photoautotrophs: if water is the source)

II. DARK REACTIONS: CARBON ASSIMILATION:
reductive carboxylation. \( \text{CO}_2 \) is absorbed and then reduced to a sugar

CHLOROPLASTS: (p 296) the ‘energy transducer,’ first seen by Leeuwenhoek
1880 Engelmann noted Spirillum tenue (chemotaxic microaerophile) formed a band around chloroplasts in Spirogyra, but only when illuminated. Concluded that chloroplasts produce \( \text{O}_2 \), but only 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 \( \text{O}_2 \) evolution
Deduced two energy capture systems: P700 (PS I) and P680 (PS II)

LIGHT HARVESTING PHOTOSYNTHETIC UNIT acts as antenna:
ACCESSORY PIGMENTS: Collect light at other \( \lambda \), transfer energy by resonance: group of 250-300 antennae chlorophyll molecules, + carotenes

carotenoids absorb in violet to green (thus look yellow-orange)
phycobilins absorb in green to orange (appear purple) (below)

NADP⁺ REDUCTION: Photoreduction occurs in PS I:
1) chlorophyll: 2nd absorbed photon activates electron, passed to
2) bound ferredoxin, then to
3) then a flavoprotein
4) then to NADP reductase: NADP⁺ to produce NADPH

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