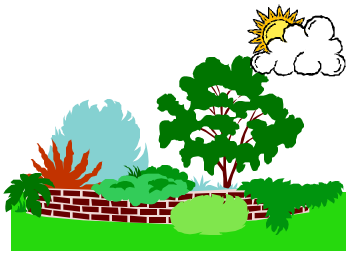
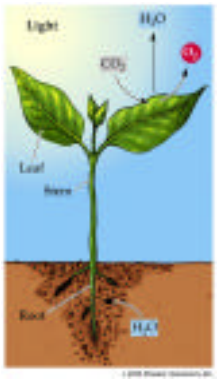
Chapter 8: Photosynthesis: energy from the sun?

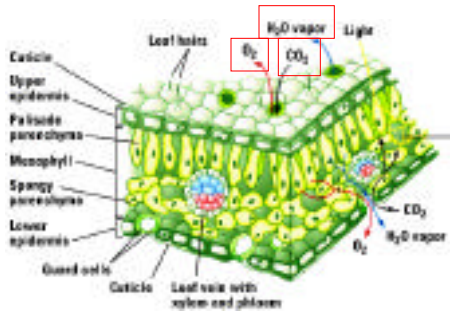
Autotrophic organisms

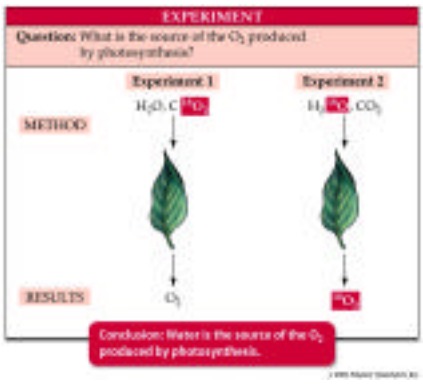
✓Carbon dioxide
✓Water
✓Sunlight



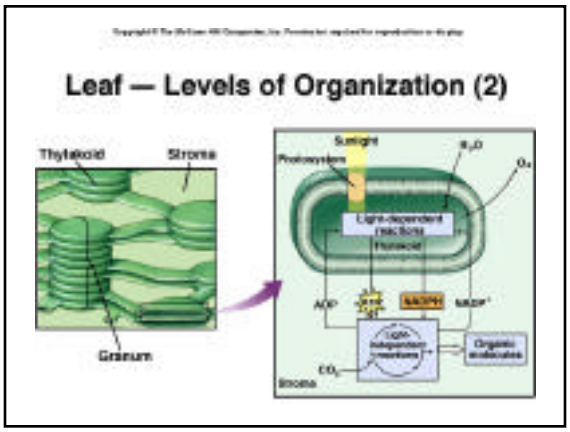


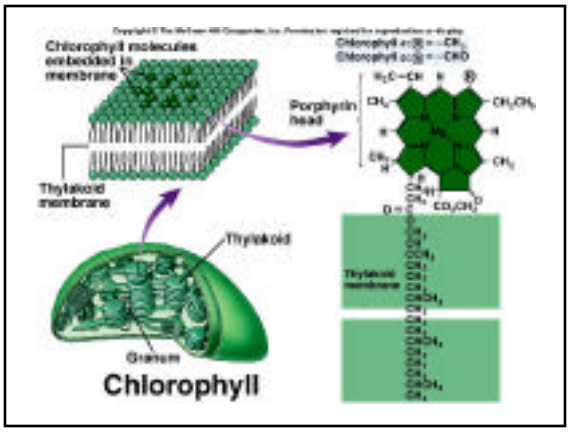
Leaf structure





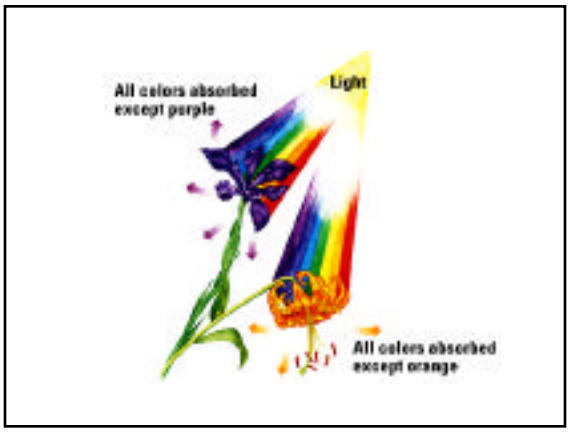
Leaf organization

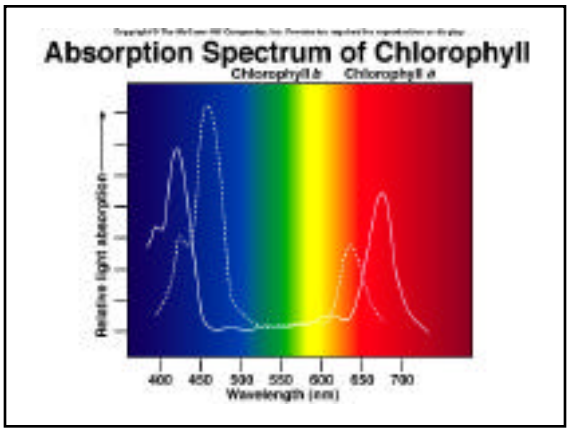


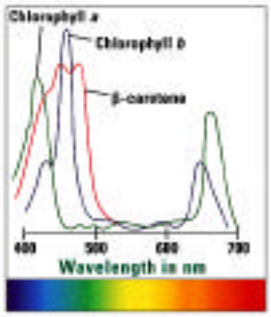


Photosynthesis

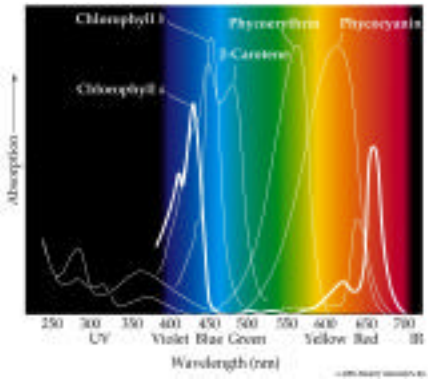
$$6CO_2 + 6H_2O \xrightarrow{\text{sunlight}} C_6H_{12}O_6 + 6O_2$$

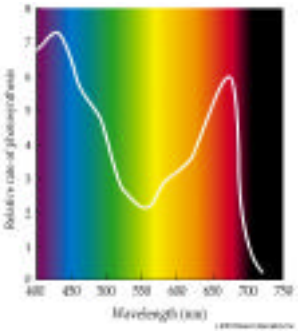




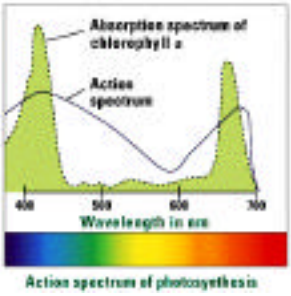


Chlorophyll absorbs red and blue photons





Other pigments (orange/yellow carotenoids) absorb light (blue/green) energy. It is transferred to chlorophyll



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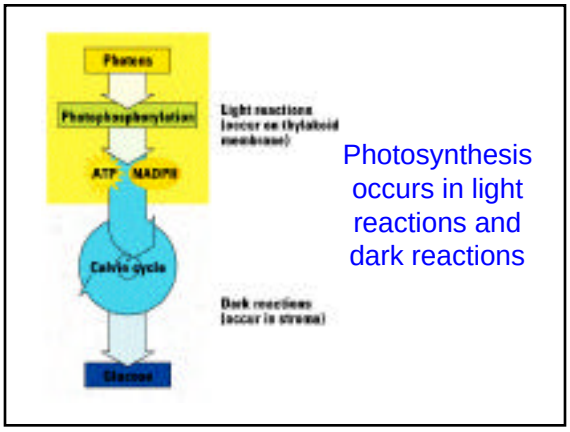
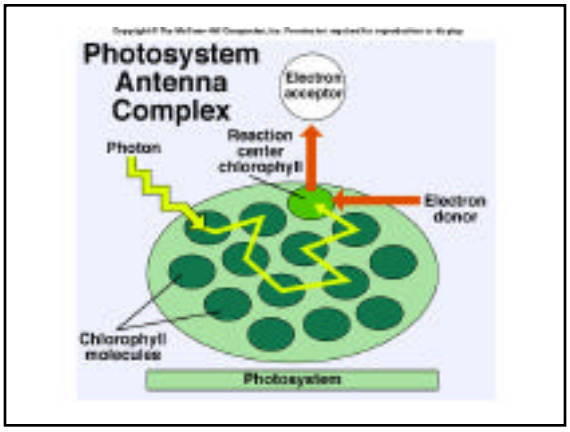
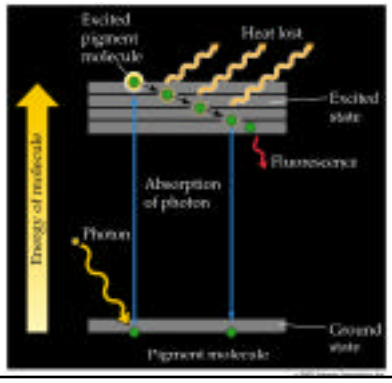
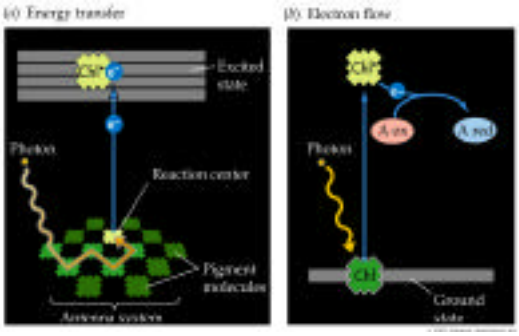


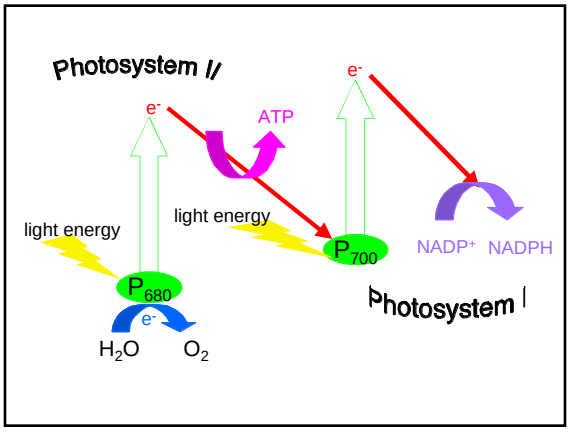


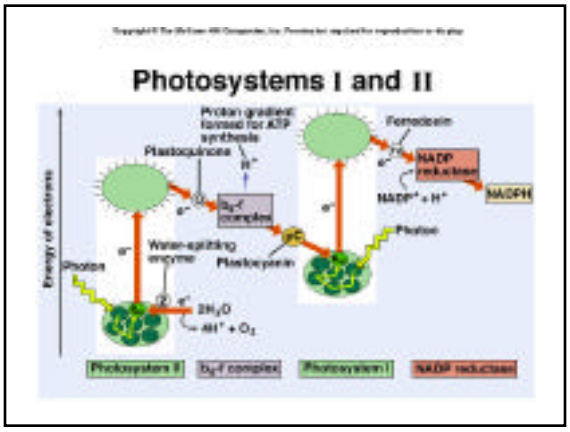
Fluorescence

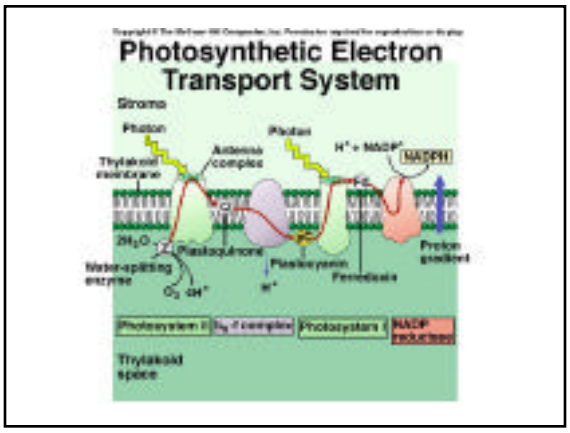


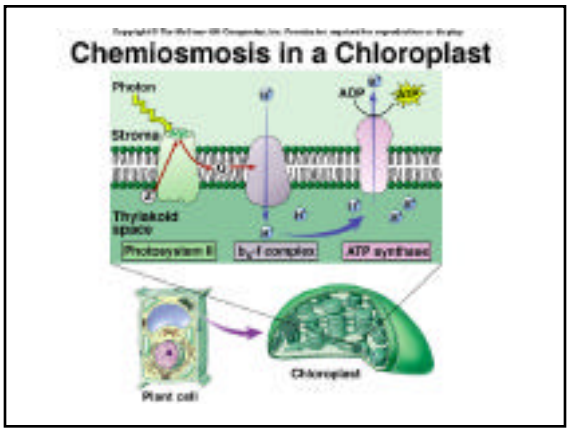
Energy transfer to the ETS





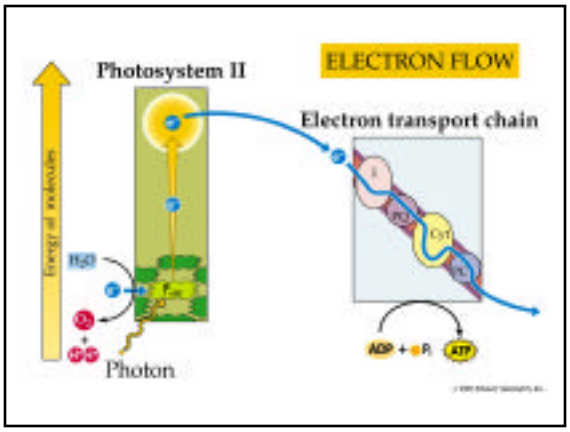


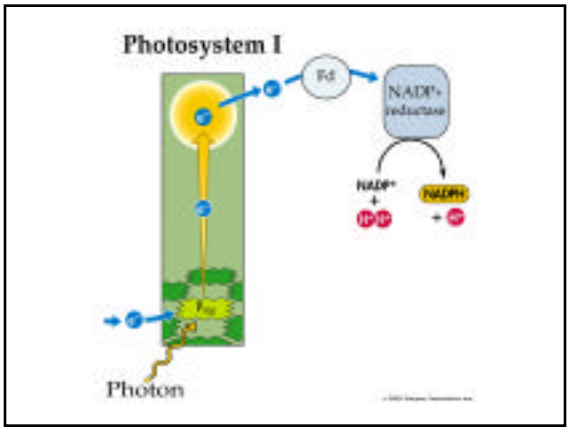




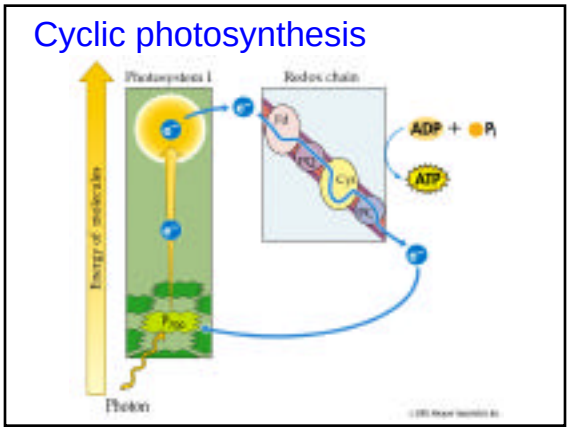
Light-dependent reactions

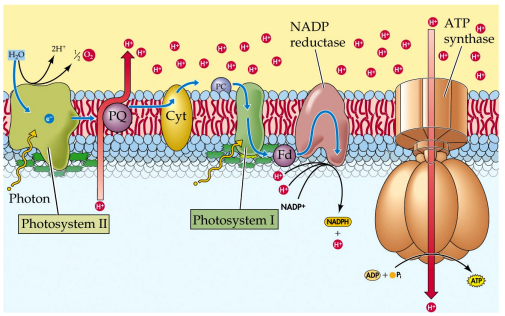
- ✓Occur in thylakoid membranes.
- ✓Photosystem II generates ATP using a proton motive force.
- ✓Photosystem I provides high energy electrons to $NADP^+$ to produce NADPH.
- ✓ATP and NADPH are used in the dark (light independent) reactions.



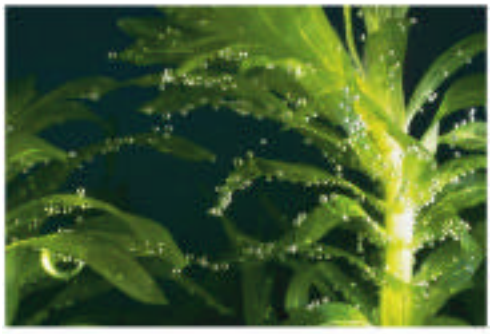


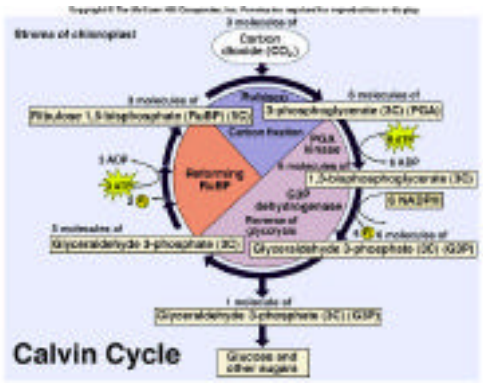
Cyclic photosynthesis



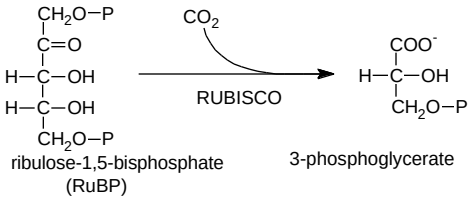


Elodea



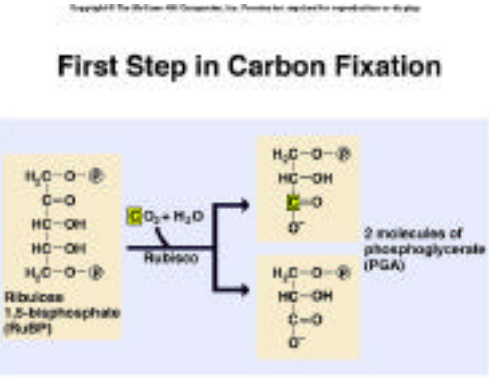


Dark reactions I: Carbon fixation

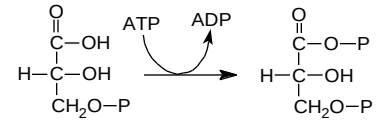


ribulose-1,5-bisphosphate (RuBP)

3-phosphoglycerate



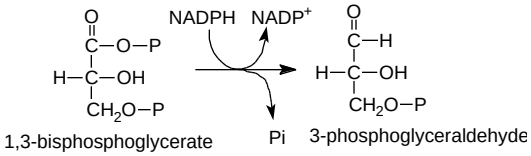
Activating the carbon chain



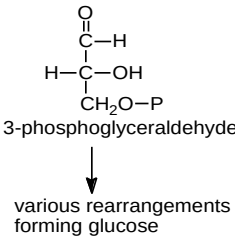
3-phosphoglycerate

1,3-bisphosphoglycerate

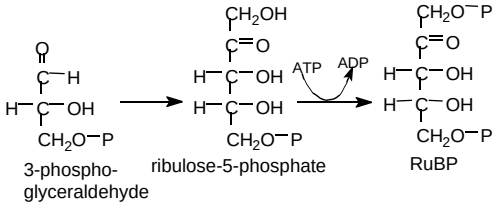
Reducing 3-PGA



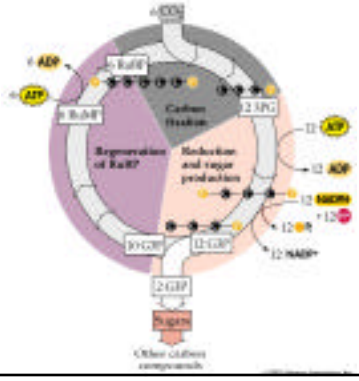
Dark reactions II: Producing sugars

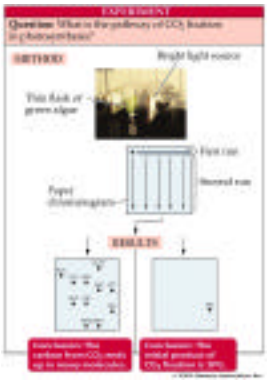


Dark reactions III: Regenerating RuBP



Calvin-Benson cycle





Photosynthesis

$$6CO_2 + 6H_2O \xrightarrow{\text{sunlight}} C_6H_{12}O_6 + 6O_2$$

Factors Influencing Rate of photosynthesis

- ✓ H_2O
- ✓ CO_2
- ✓ Light
- ✓ Nutrients
- ✓ Temperature

C3 plants

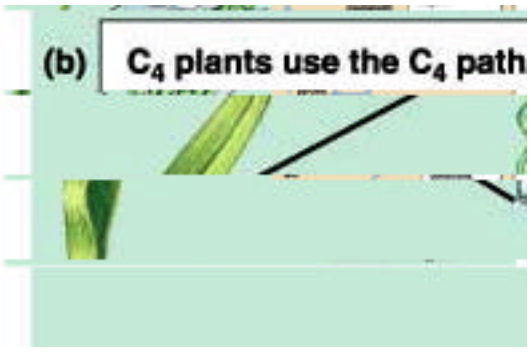
- ✓ Fix CO_2 into the 3-carbon phosphoglycerate
- ✓ Most trees, shrubs, wheat, oats, rice, and bamboo, Kentucky blue grass.
- ✓ Survive in a warm/cool and moist climate.

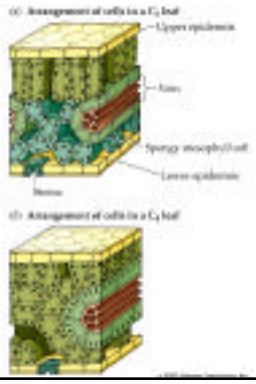
C3 plant structure

C4 plants

- ✓ Fix CO_2 into oxaloacetate (and then malate). This serves as a CO_2 storage.
- ✓ 2 types of photosynthetic cells
  - ✒ Mesophyll cells and bundle sheath cells
- ✓ Sugarcane, maize, sorghum, other grasses (crab grass) and sedges.
- ✓ Effective when CO_2 is limiting and minimizes water loss.
- ✓ Hot and dry climates

C4 plant structure

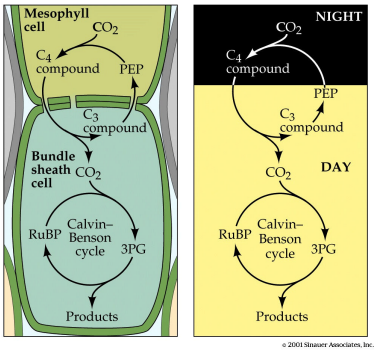




CAM plants

- ✓Crassulacean Acid Metabolism
- ✓Succulents, cacti, pineapples, lilies, orchids
- ✓Drought tolerant plants.

C4 and CAM



C3 and C4 plants

8.1 Comparison of Photosynthesis in C_3 and C_4 Plants

VARIABLE	C_3 PLANTS	C_4 PLANTS
Photorespiration	Extensive	Minimal
Performs Calvin–Benson cycle?	Yes	Yes
Primary CO_2 acceptor	RuBP	PEP
CO_2-fixing enzyme	Rubisco (RuBP carboxylase/oxygenase)	PEP carboxylase
First product of CO_2 fixation	3PG (3-carbon compound)	Oxaloacetate (4-carbon compound)
Affinity of carboxylase for CO_2	Moderate	High
Photosynthetic cells of leaf	Mesophyll	Mesophyll + bundle sheath
Classes of chloroplasts	One	Two

Metabolites from the Calvin-Benson cycle