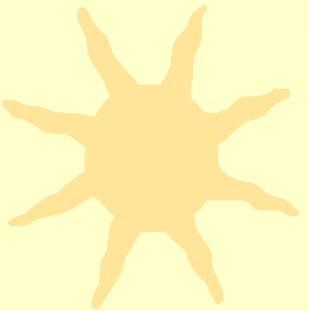
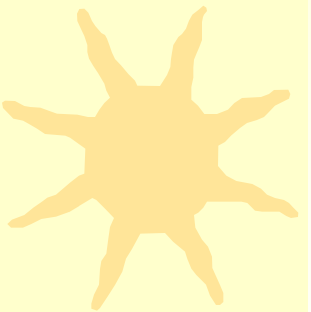
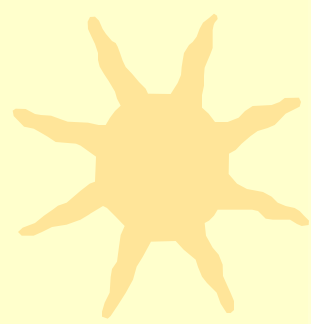


# *Where It Starts: Photosynthesis*

---

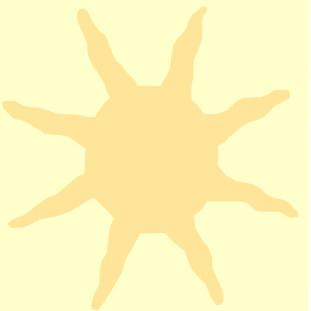


## Chapter 5



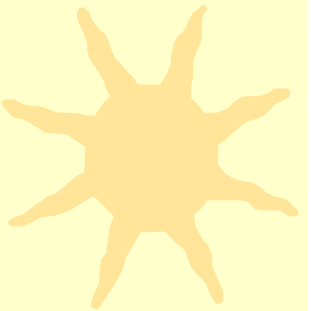
# *Photosynthesis*

---



Metabolic Pathways

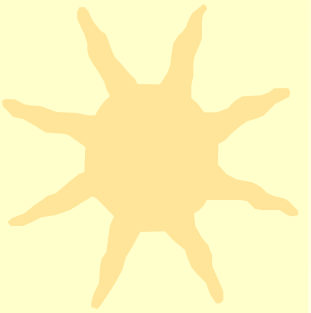
Converts light energy to chemical energy.



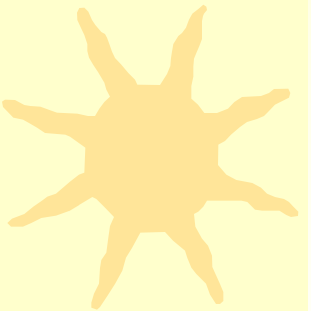


# *Photoautotrophs*

---

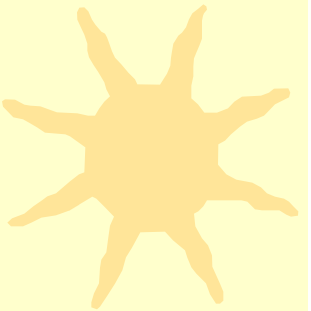


Organisms that can perform photosynthesis



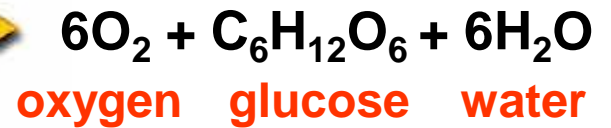
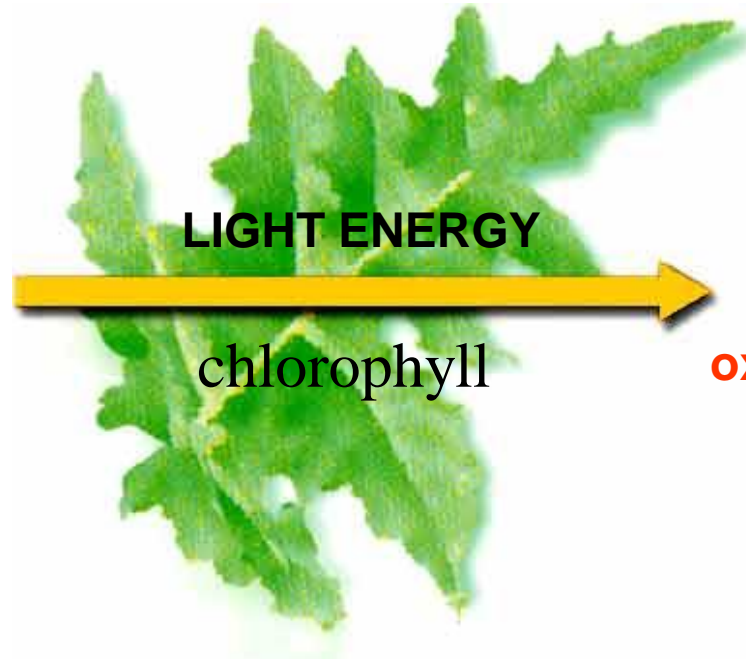
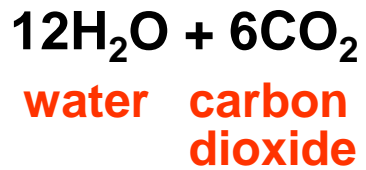
★ Cyanobacteria (prokaryotic-no chloroplast)

★ Plants



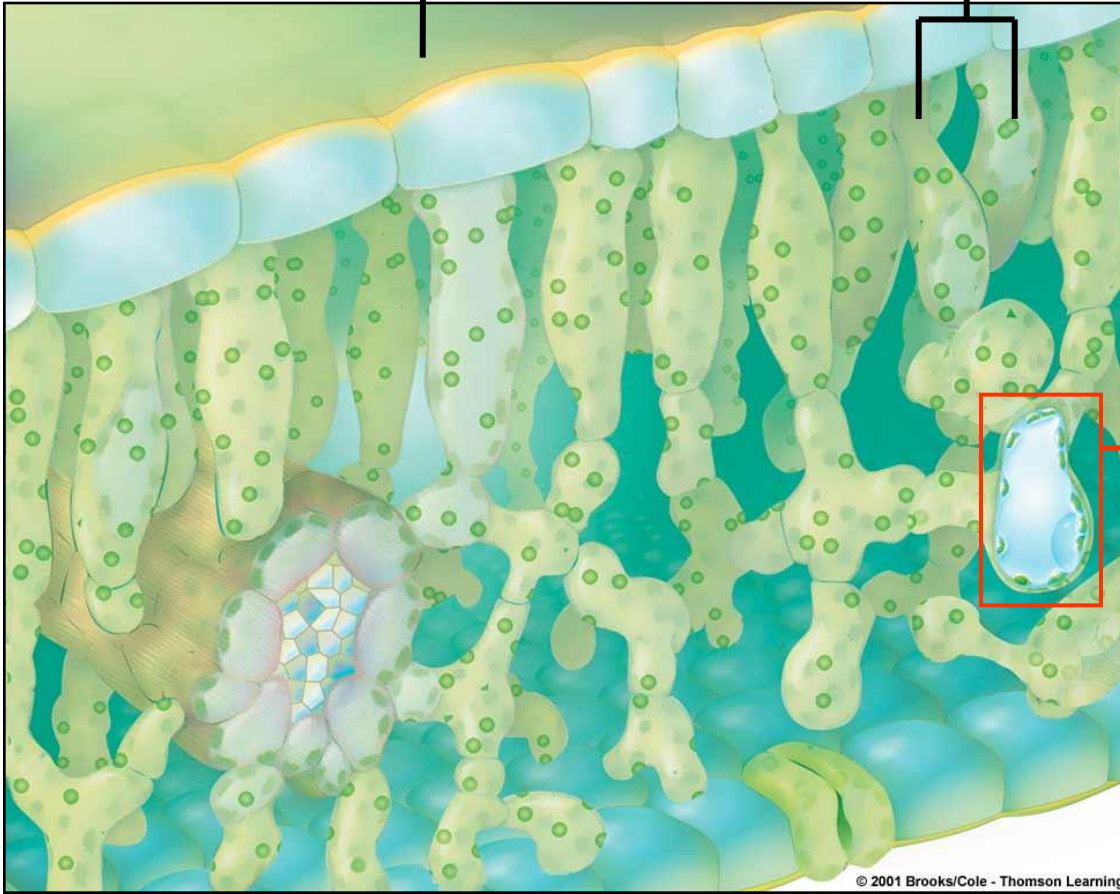
★ Algae

# Photosynthesis Equation

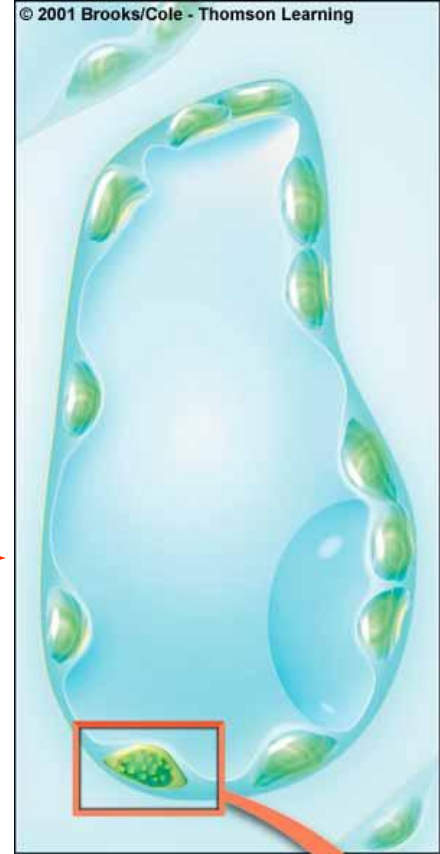


upper leaf surface

photosynthetic cells



© 2001 Brooks/Cole - Thomson Learning

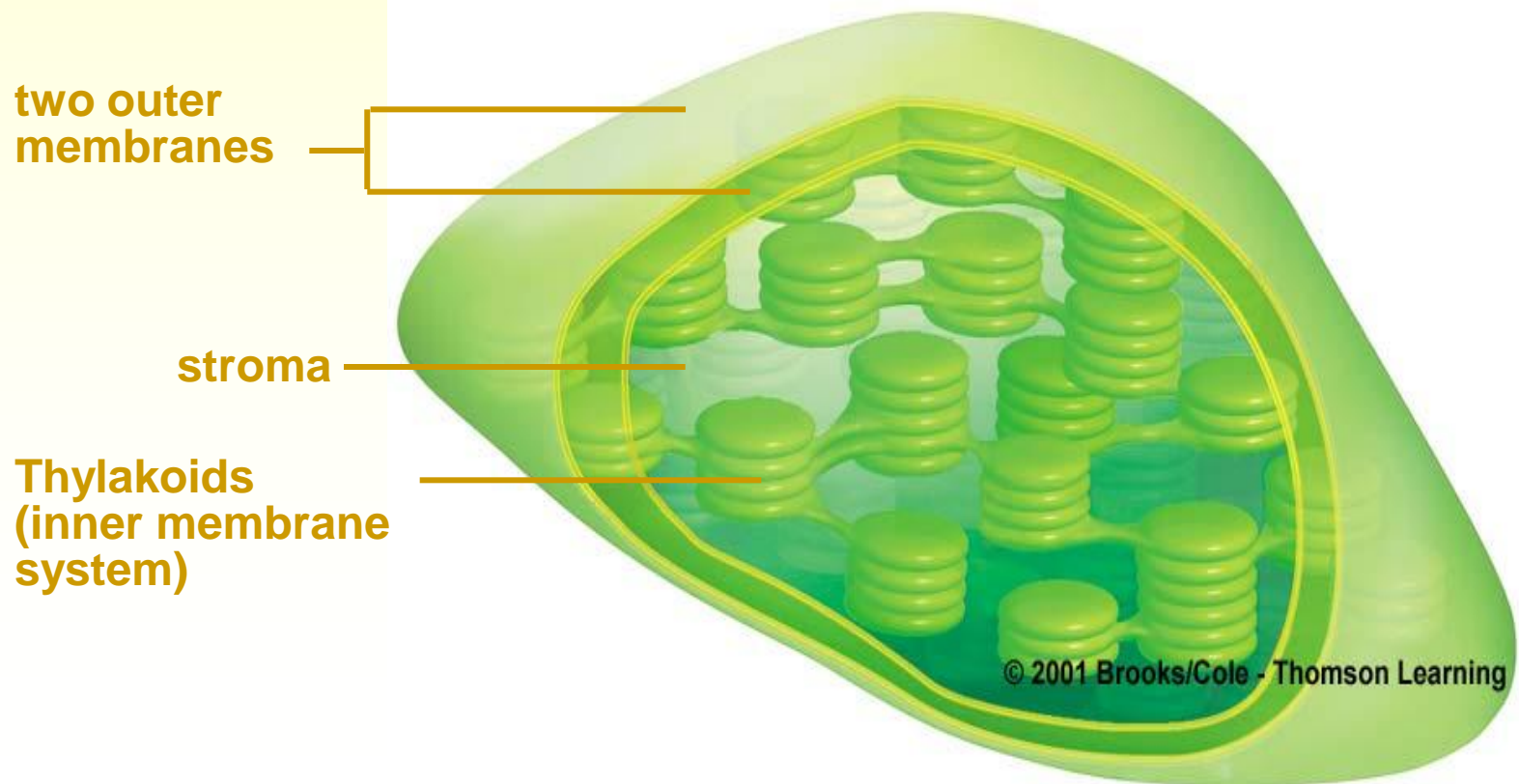


*(see next slide)*

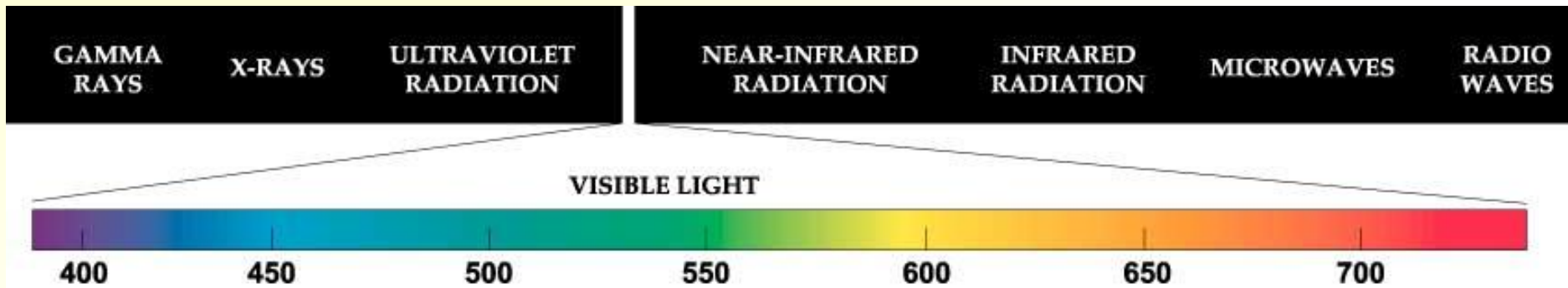
Cutaway section of leaf

# *Chloroplast*

Photosynthetic organelle in plants and algae



# *Different Types of Energy*

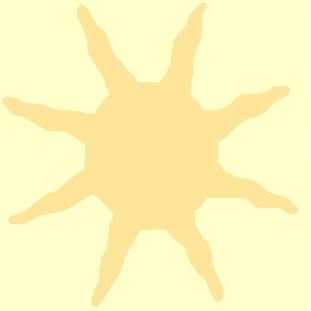


**Wavelength of light (nanometers)**

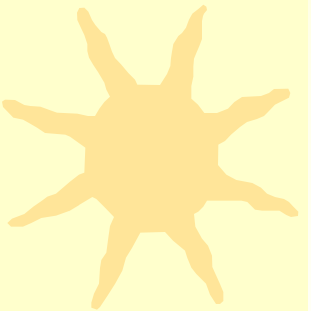


# *Visible Light Spectrum*

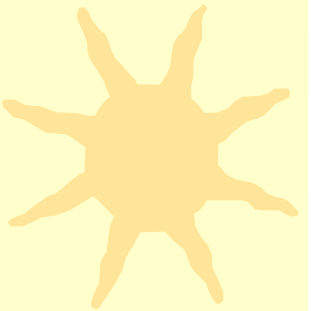
---



★ Composed of different colors



★ Violet (380 nm) to red (750 nm)



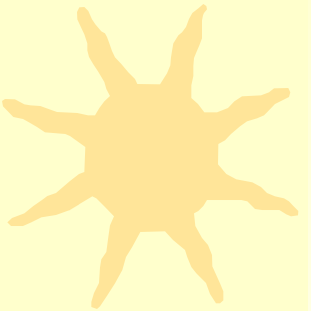
★ Longer wavelengths, lower energy



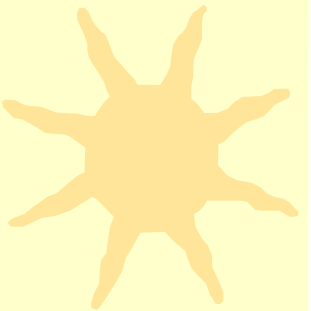


# *Pigments*

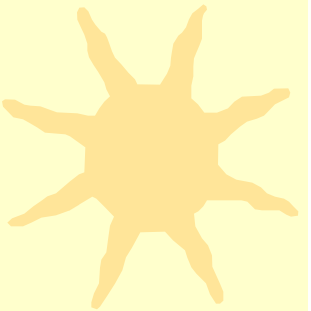
---



☼ Chemicals that interact with visible light



☼ Absorbed colors/wavelength (not seen)



☼ Reflect colors/wavelength (color seen)



# *Variety of Plant Pigment*

---



## Photosynthetic Pigments

Chlorophylls



## Accessory Pigments

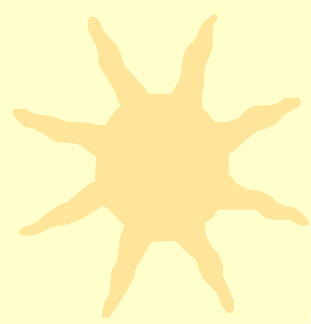
Carotenoids

Anthocyanins

Phycobilins



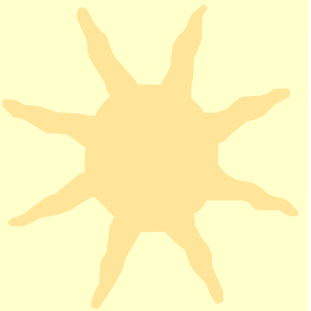
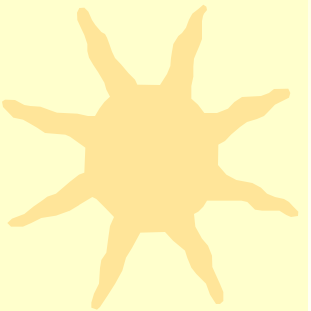
© 2005 Brooks/Cole – Thomson Learning

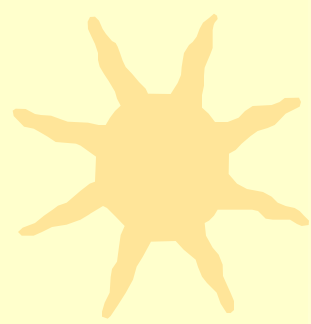


# *Photosynthesis .... a Two-Step Process*

---

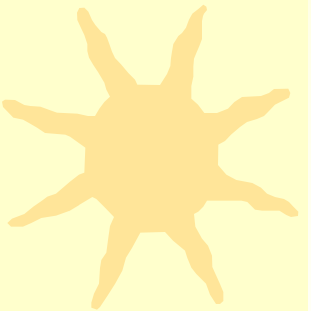
1. Light-dependent reactions
2. Light-independent reaction





# *Light Dependand Reactions*

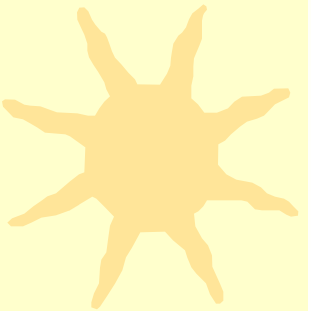
---



Pigments

Electron transport chain

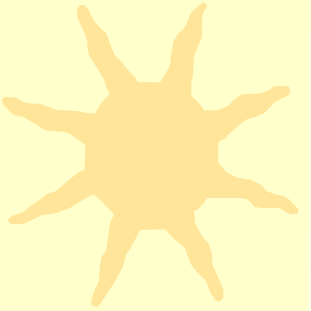
ATP Production



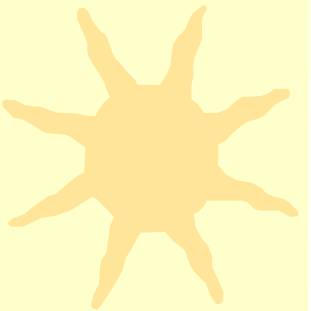


# *Photosystems*

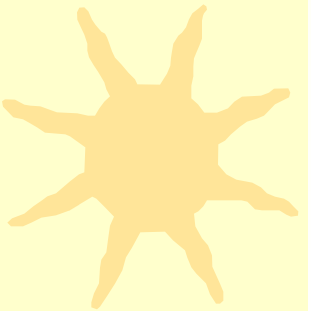
---



★ Capture light energy



★ Two types (I and II)



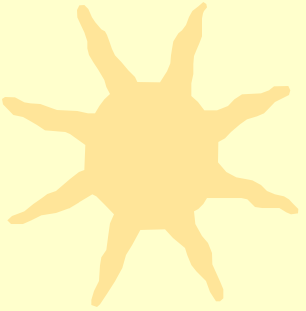
★ Composed of....

- Antenna pigments (accessory pigments)
- Reaction center (chlorophyll)

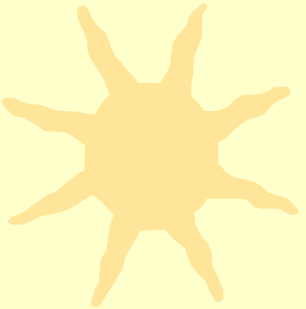


# *Electron Transfer Chains*

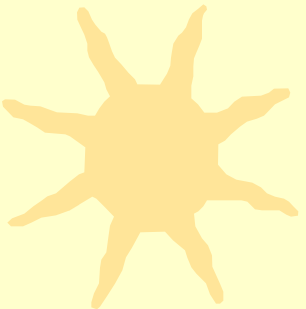
---



★ Next to photosystems



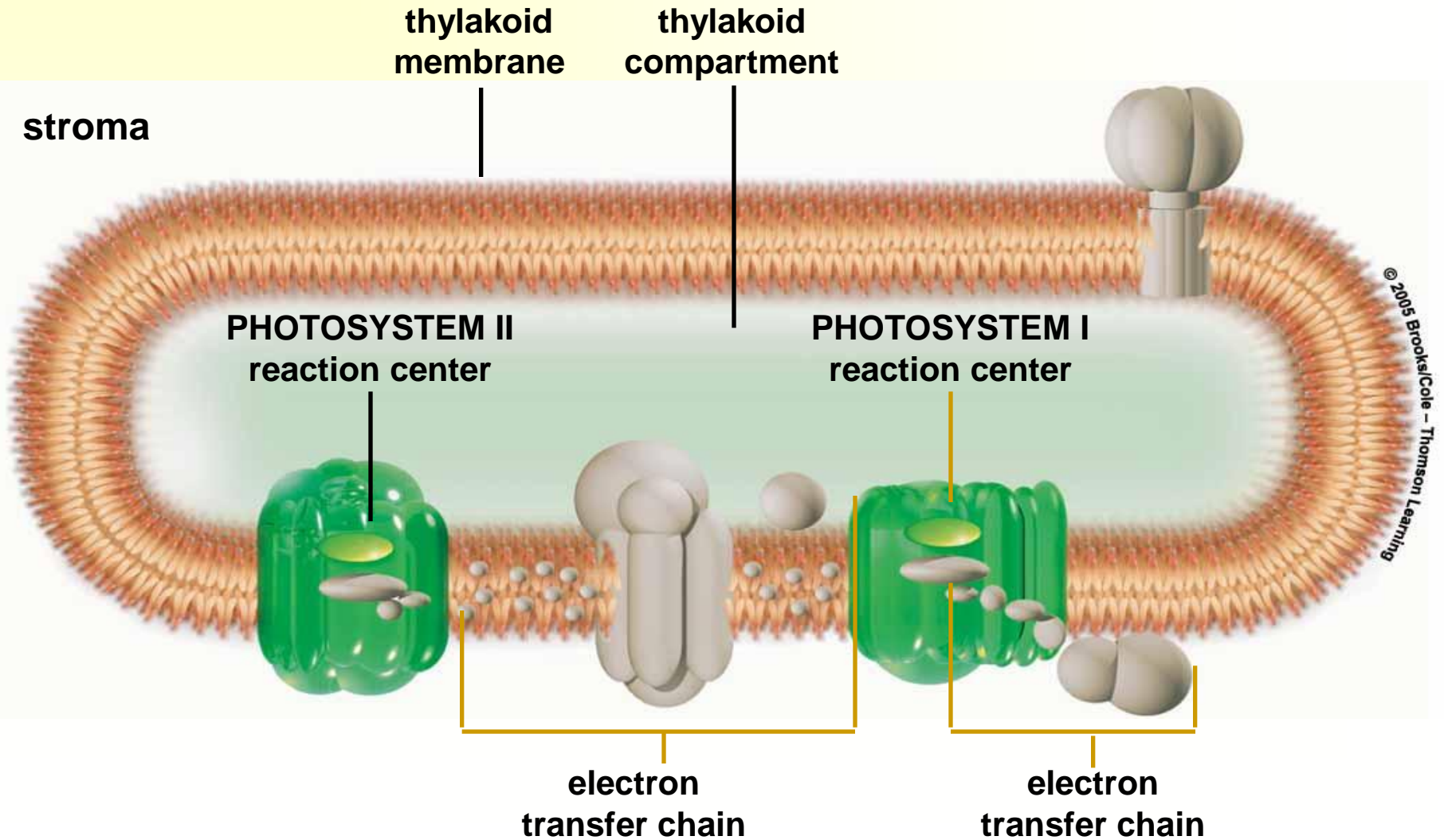
★ Accepts electrons from reaction center



★ Electrons pass along chain

★ ATP generated.

# *Thylakoid Membrane Section*

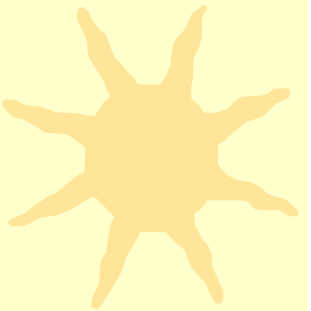
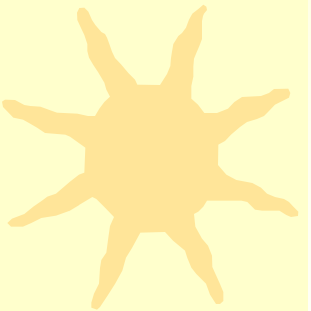
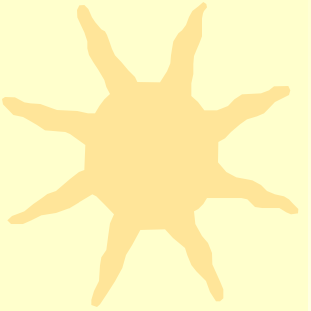






# *Light-Dependent Reactions*

---



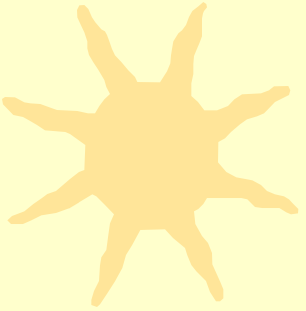
Two variants

1. Noncyclic pathway
2. Cyclic pathway

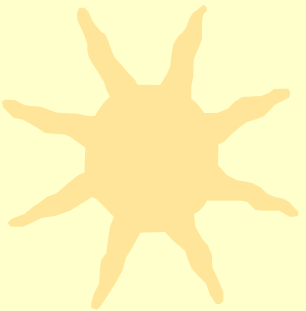


# *Noncyclic Electron Flow*

---

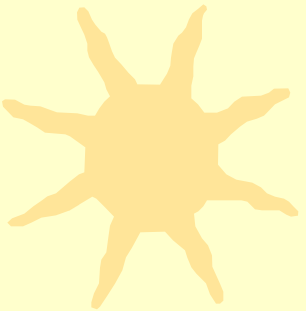


★ Two-step pathway



★ Uses both photosystems (I and II)

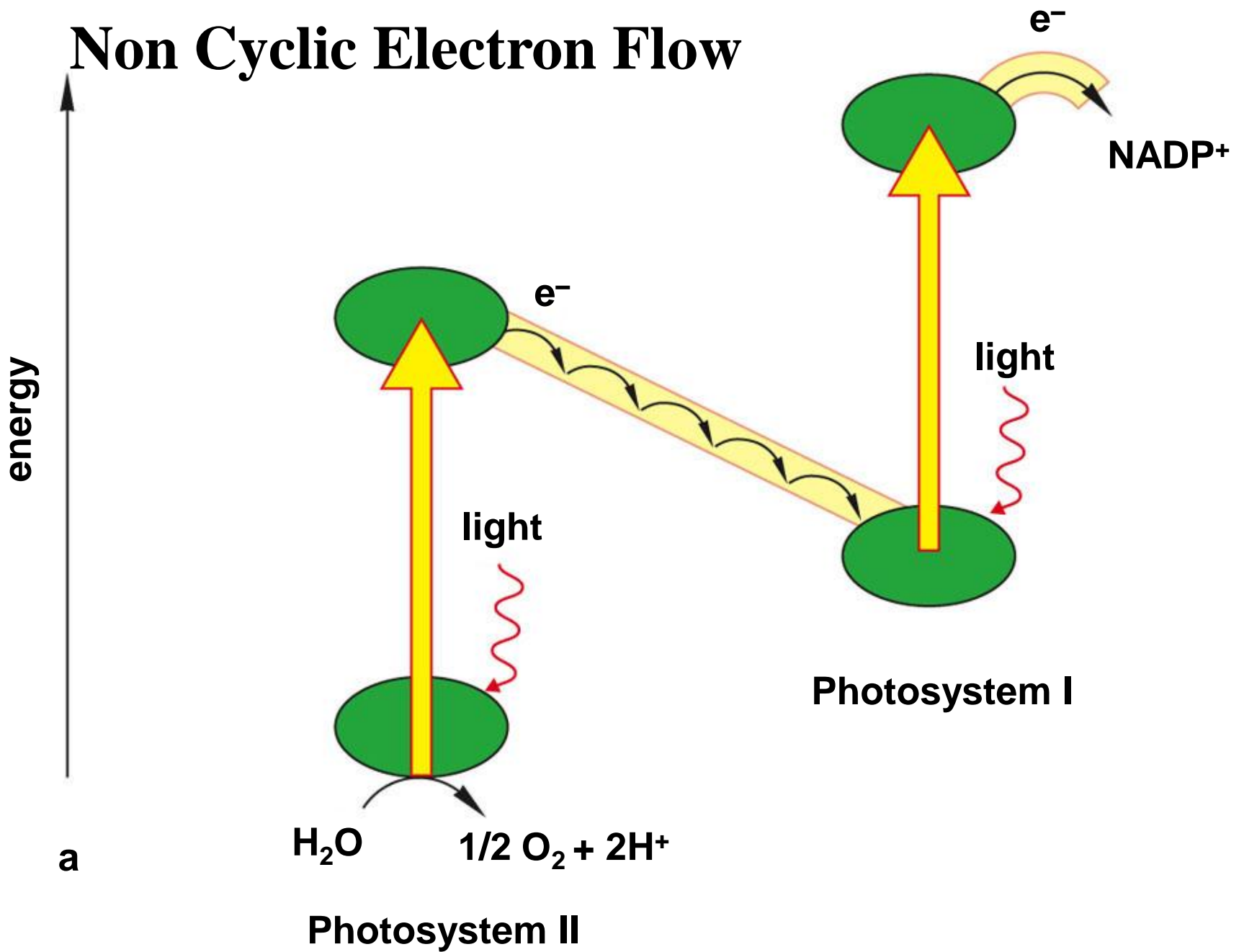
★ Produces ATP and NADPH



★ Split water

★ Release oxygen

# Non Cyclic Electron Flow

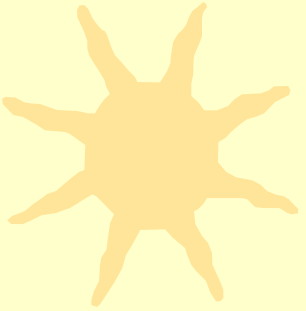




# *ATP Synthesis*

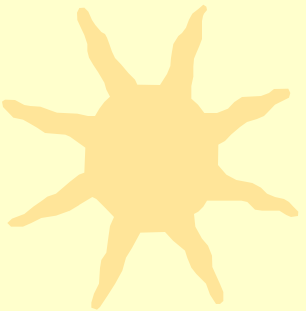
## *Noncyclic Pathway*

---



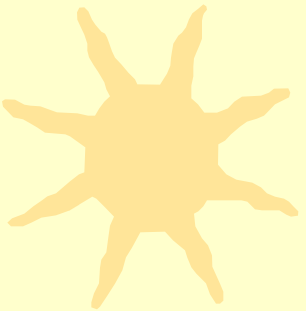
★  $H^+$  concentrated in thylakoid

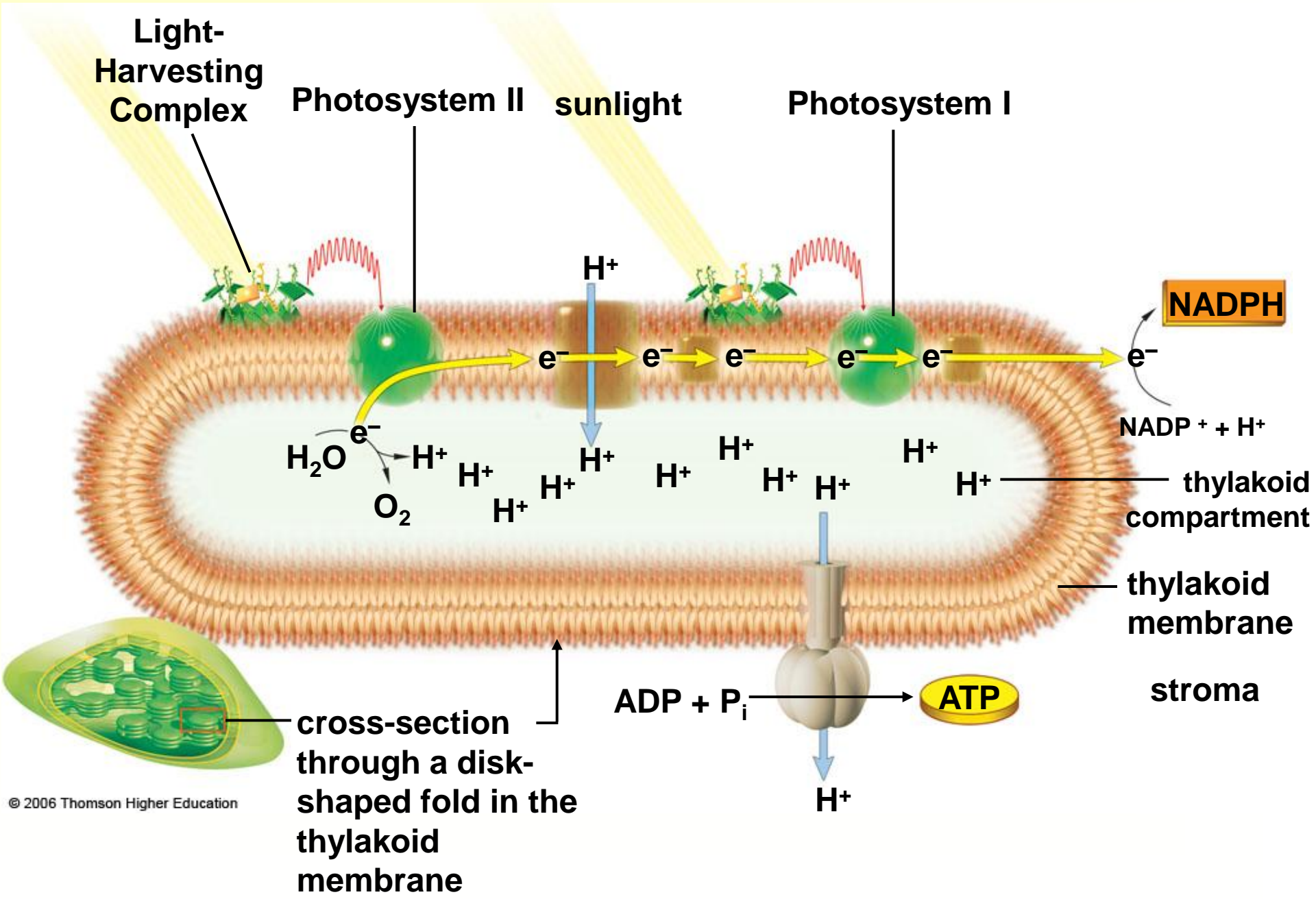
★  $H^+$  Passive transport through ATP synthase



★ ATP produced

★ Chemiosmosis



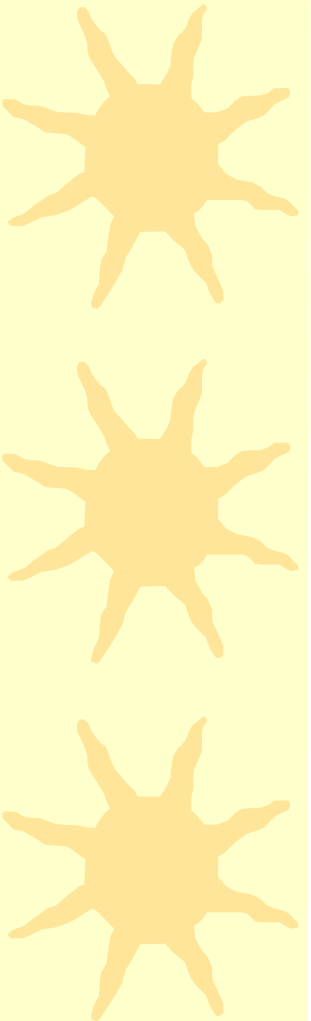


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Fig. 5-7, p.77



# *Non Cyclic Electron Flow: Summary*



## Reactants

- ★ Location: Thylakoid Membranes
- ★ Light
- ★ Photosystem I and II with Chlorophyll
- ★ Water
- ★ Electron Transport Chains
- ★ ADP
- ★ NADP<sup>+</sup>

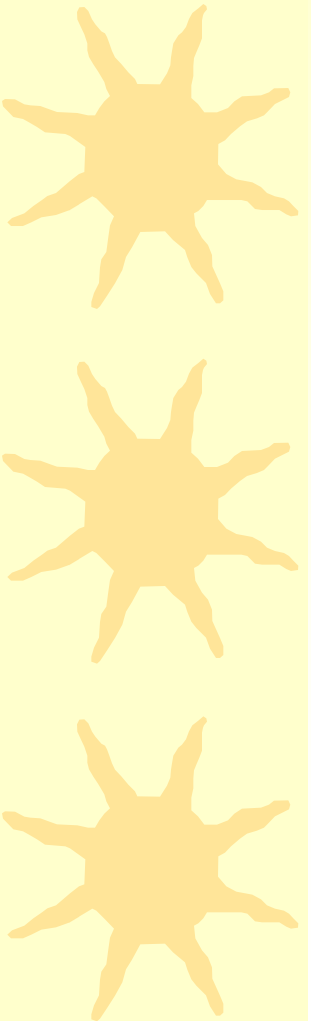
## Products

- ★ Oxygen
- ★ ATP
- ★ NADPH



# *Cyclic Electron Flow*

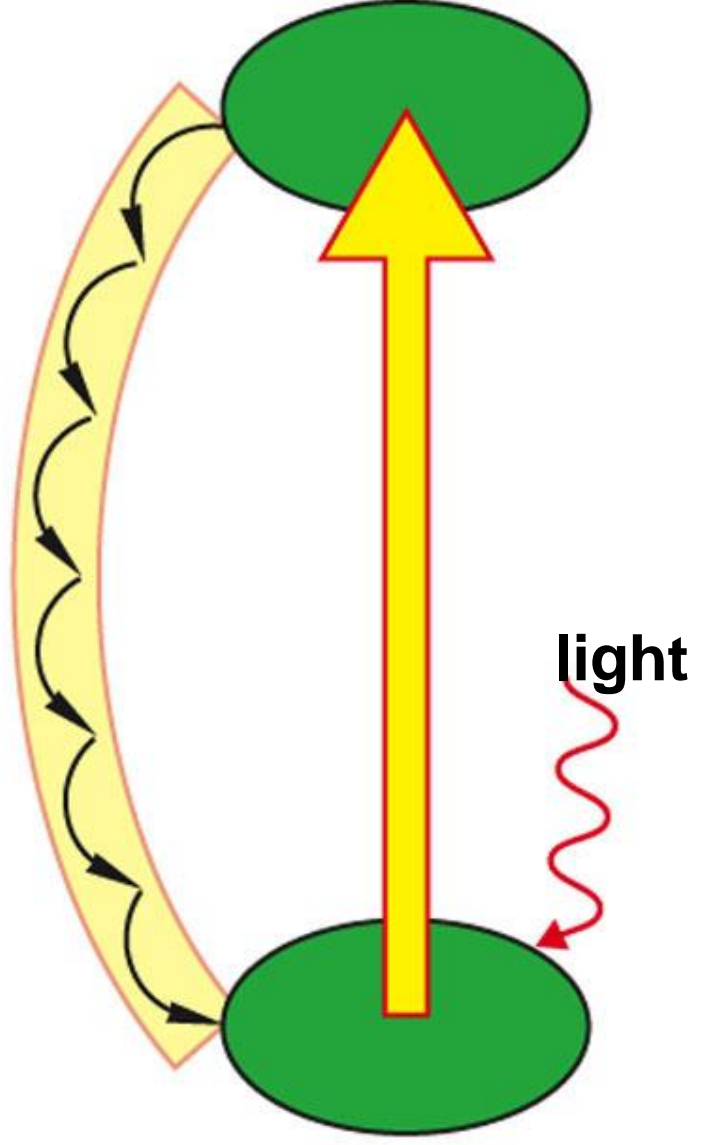
---



- ★ Photosystem I only
- ★ Electrons
  - Donated by chlorophyll *a*
  - Passed to electron transfer chain
  - Passed back to photosystem I
- ★ Electron flow drives ATP formation
- ★ No NADPH is formed

# Cyclic Electron Flow

$e^-$   
energy



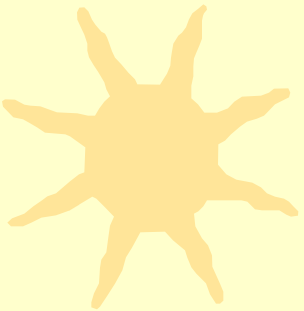
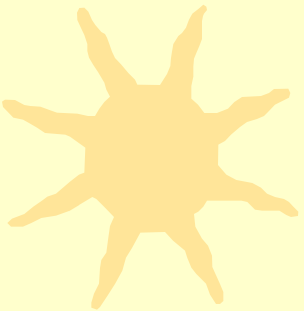
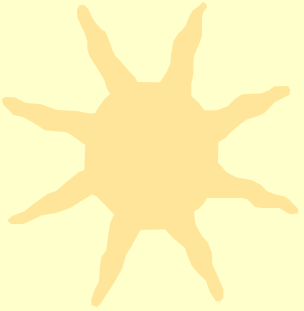
b

Photosystem I





# *Cyclic Electron Flow: Summary*



## Reactants

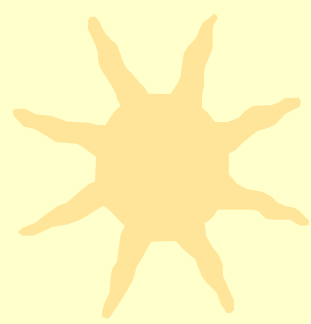
- ★ Location: Thylakoid Membranes
- ★ Light
- ★ Photosystem I with Chlorophyll
- ★ Electron Transport Chain
- ★ ADP

## Products

- ★ ATP

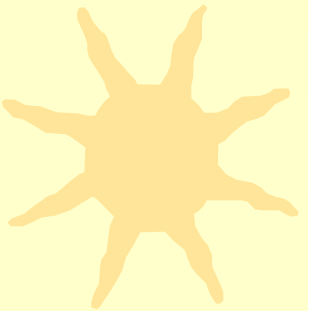
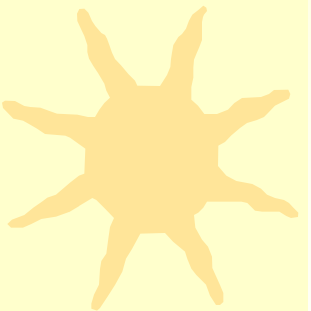
# Photosynthesis Equation





# *Light Independent reaction*

---

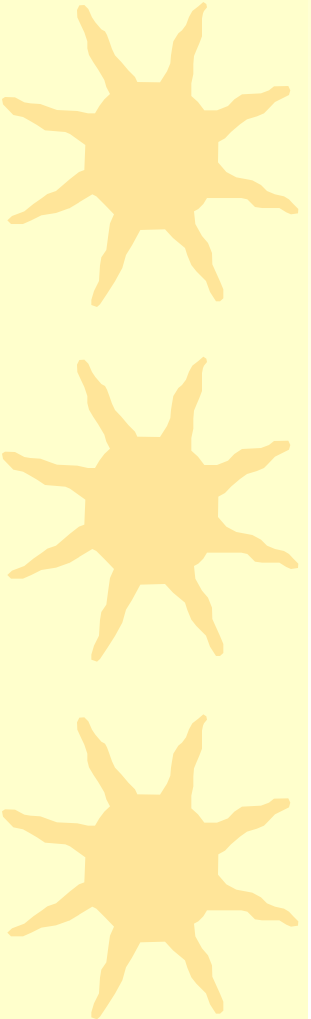


Synthesis of glucose



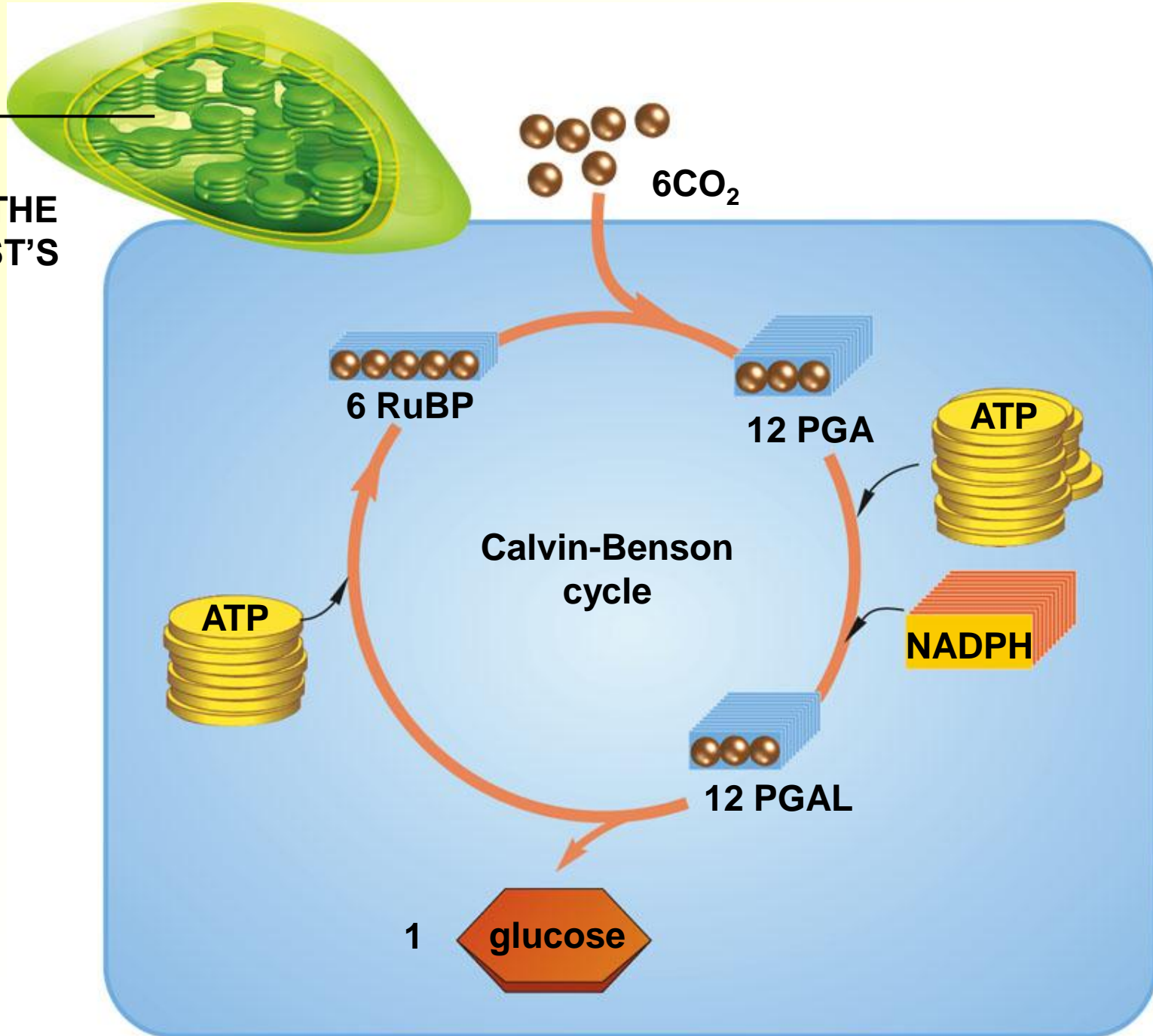
# *Light-Independent reaction*

---



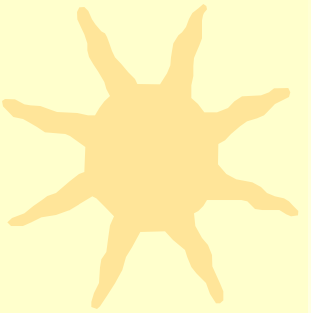
- ★ Fixes carbon dioxide
- ★ Synthesizes sugar
- ★ Independent of light
- ★ Take place in the stroma
- ★ Calvin-Benson cycle

THESE REACTIONS PROCEED IN THE CHLOROPLAST'S STROMA



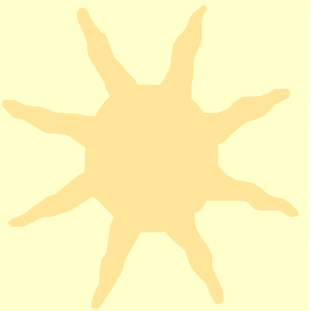


# *Light Independent reaction*



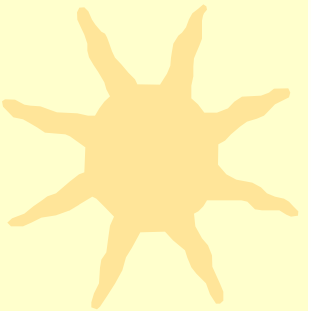
## ★ Reactants

- Carbon dioxide
- ATP
- NADPH
- RuBP



## ★ Products

- Glucose
- ADP
- NADP<sup>+</sup>
- RuBP

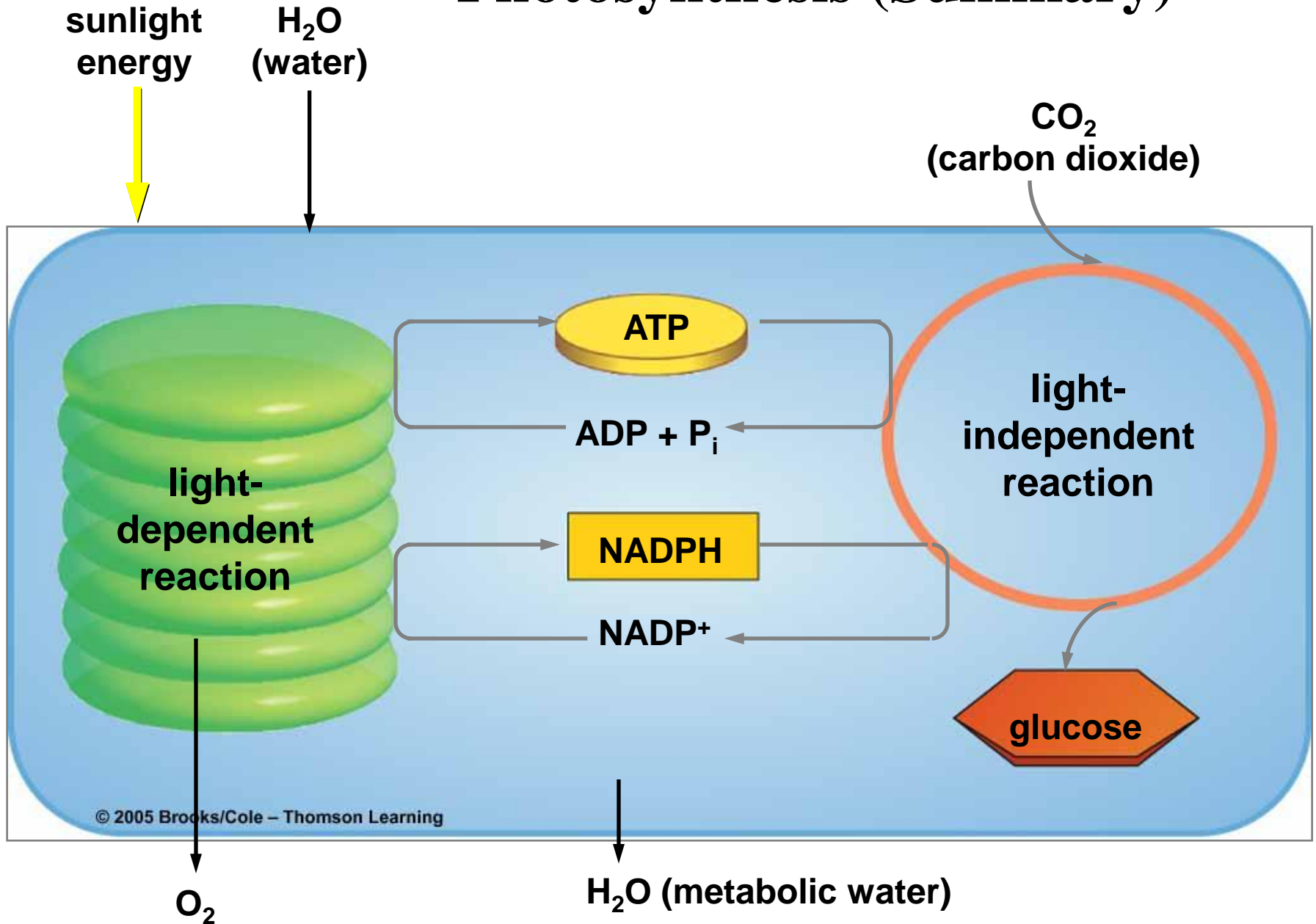


Reaction pathway is cyclic and RuBP (ribulose biphosphate) is used and produced

# Photosynthesis Equation



# Photosynthesis (Summary)

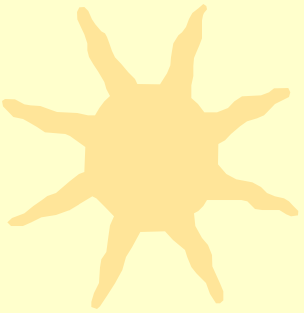




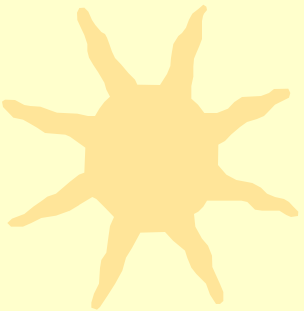


# *The C3 Pathway*

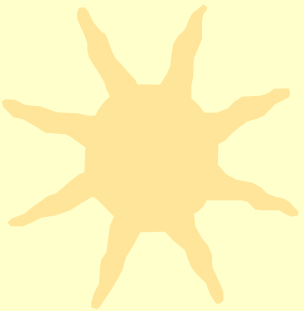
---



★ The standard photynthesis pathway



★ The first stable intermediate is a three-carbon  
PGA



★ Because the first intermediate has three carbons,  
the pathway is called the C3 pathway



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**Leaves of basswood,  
a typical C3 plant. Far right,  
basswood leaf cross section.**

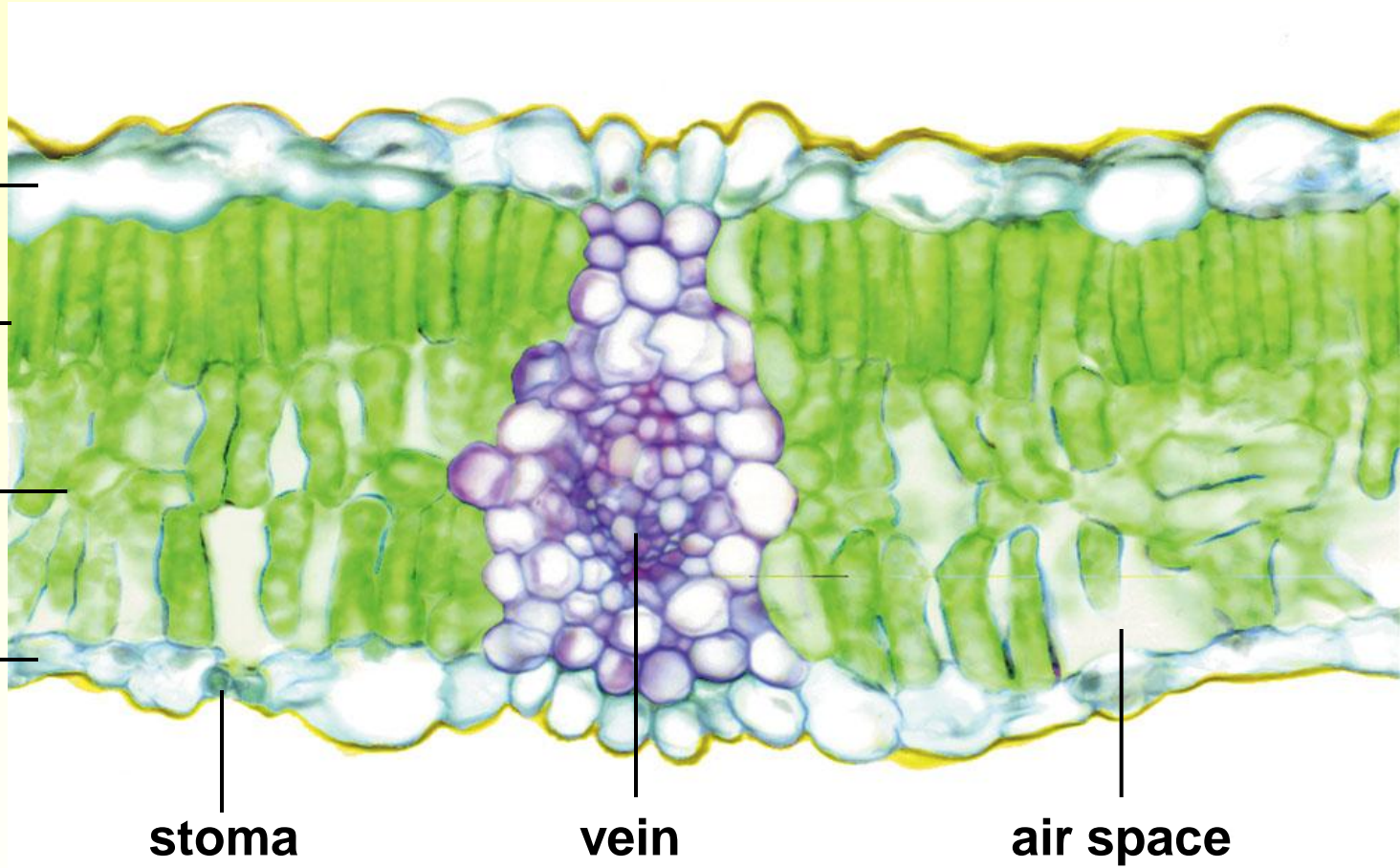
**Fig. 5-8, p.78**

**upper  
epidermis**

**palisade  
mesophyll**

**spongy  
mesophyll**

**lower  
epidermis**



**stoma**

**vein**

**air space**

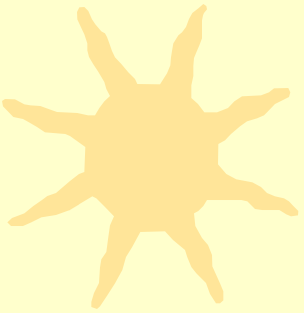
© 2006 Brooks/Cole - Thomson

**Fig. 5-8, p.78**



# *Photorespiration in C3 Plants*

---

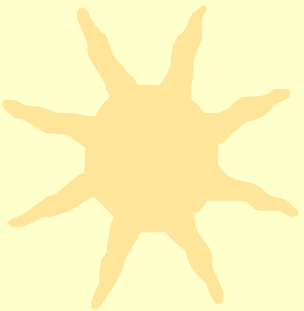


★ On hot, dry days stomata close

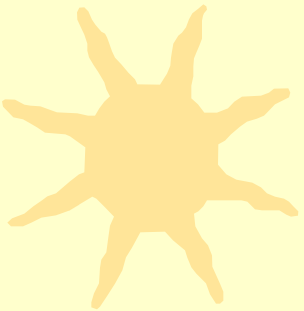
★ Inside leaf

– Oxygen levels rise

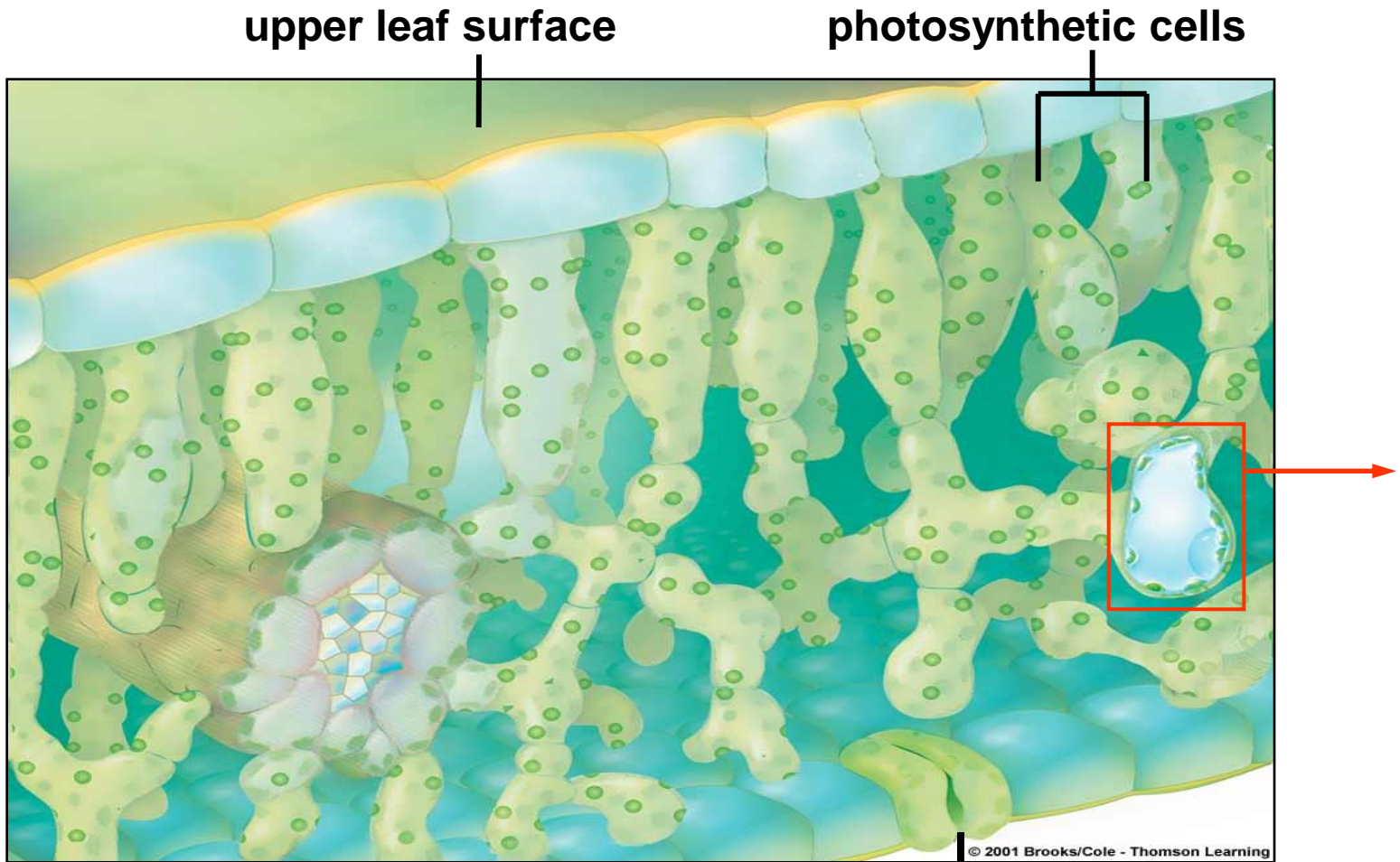
– Carbon dioxide levels drop



★ RuBP bonds to oxygen instead of carbon dioxide



★ Only one PGAL forms instead of two glucose

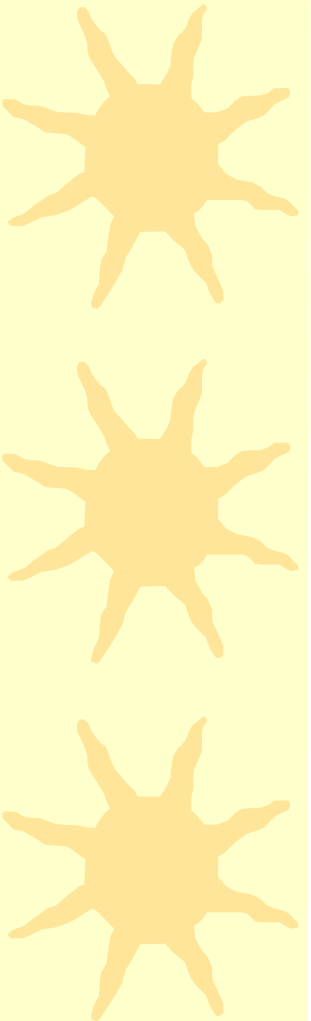


**Cutaway section of leaf**

stoma



# *C4 Plants*



- ★ Carbon dioxide is fixed twice
  - Carbon dioxide is stored as a four carbon compound
  - Carbon dioxide is released from the compound for use in Calvin-Benson cycle
- ★ Evolutionary defense against photorespiration
- ★ Corn and Crabgrass are examples



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**Fig. 5-9, p.79**

upper  
epidermis

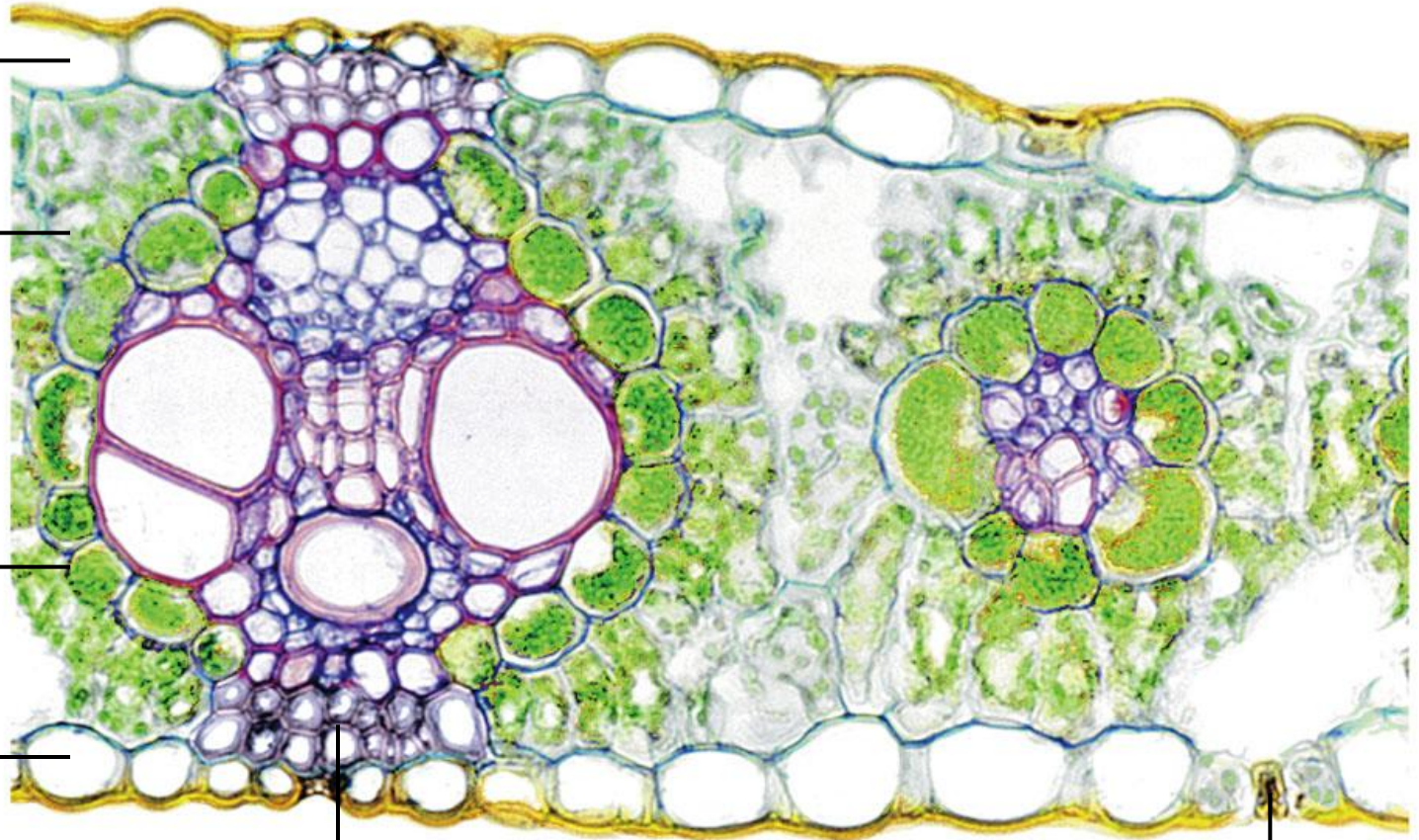
mesophyll  
cell

bundle-  
sheath cell

lower  
epidermis

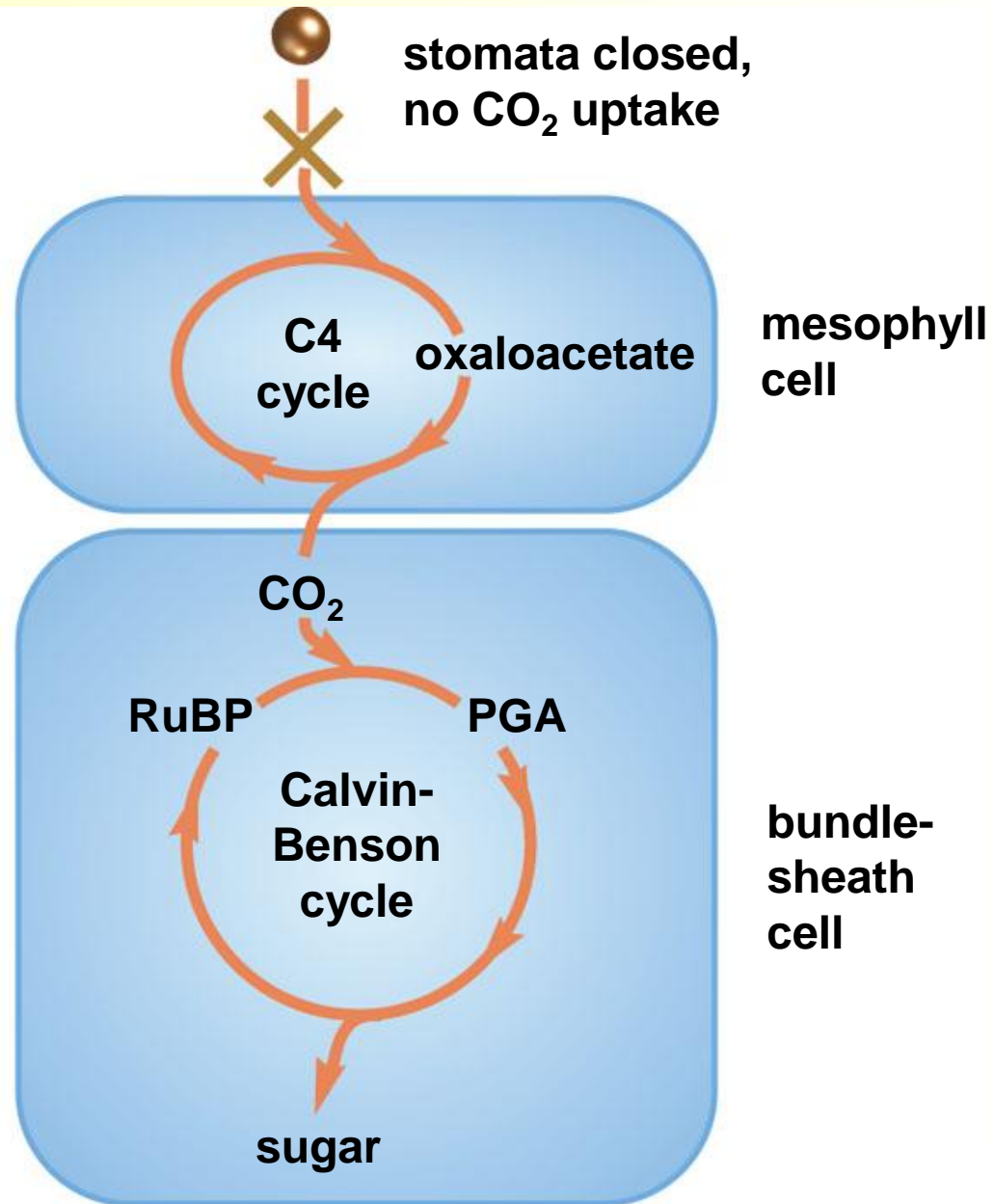
vein

stoma



**Corn leaf, cross-section**

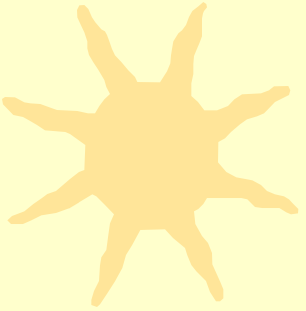






# *CAM Plants*

---

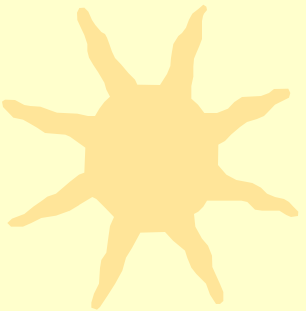


★ Carbon is fixed twice (in same cells)

★ Night

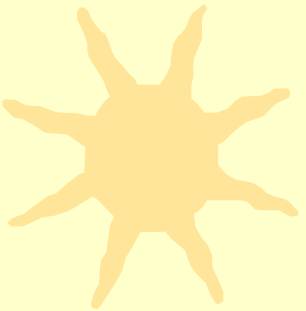
– Stomates open for gas exchange.

– Carbon dioxide is fixed by repeated turns of a type of C4 cycle



★ Day

– Carbon dioxide is released and fixed in Calvin-Benson cycle

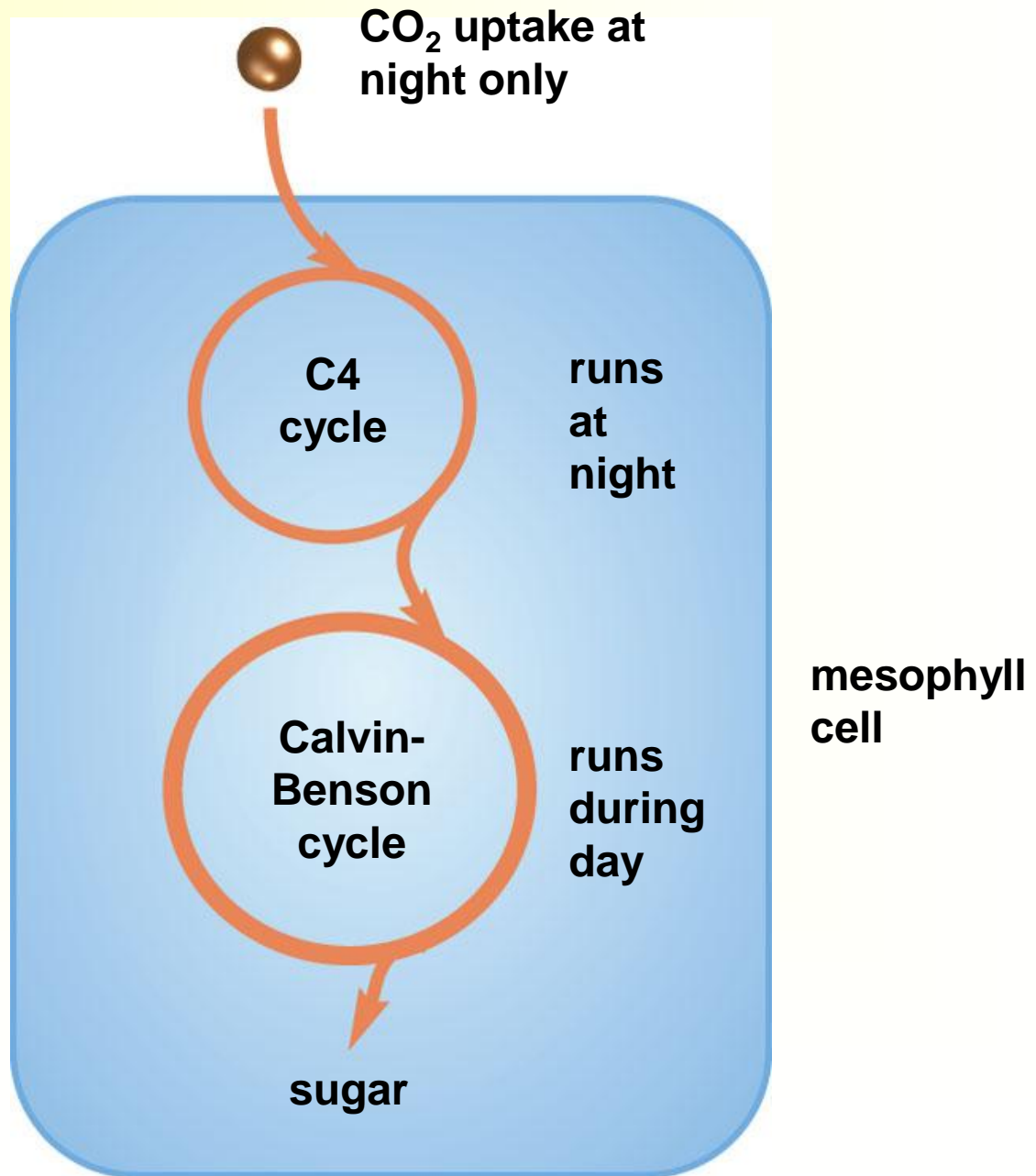


★ Cacti and other fleshy plants

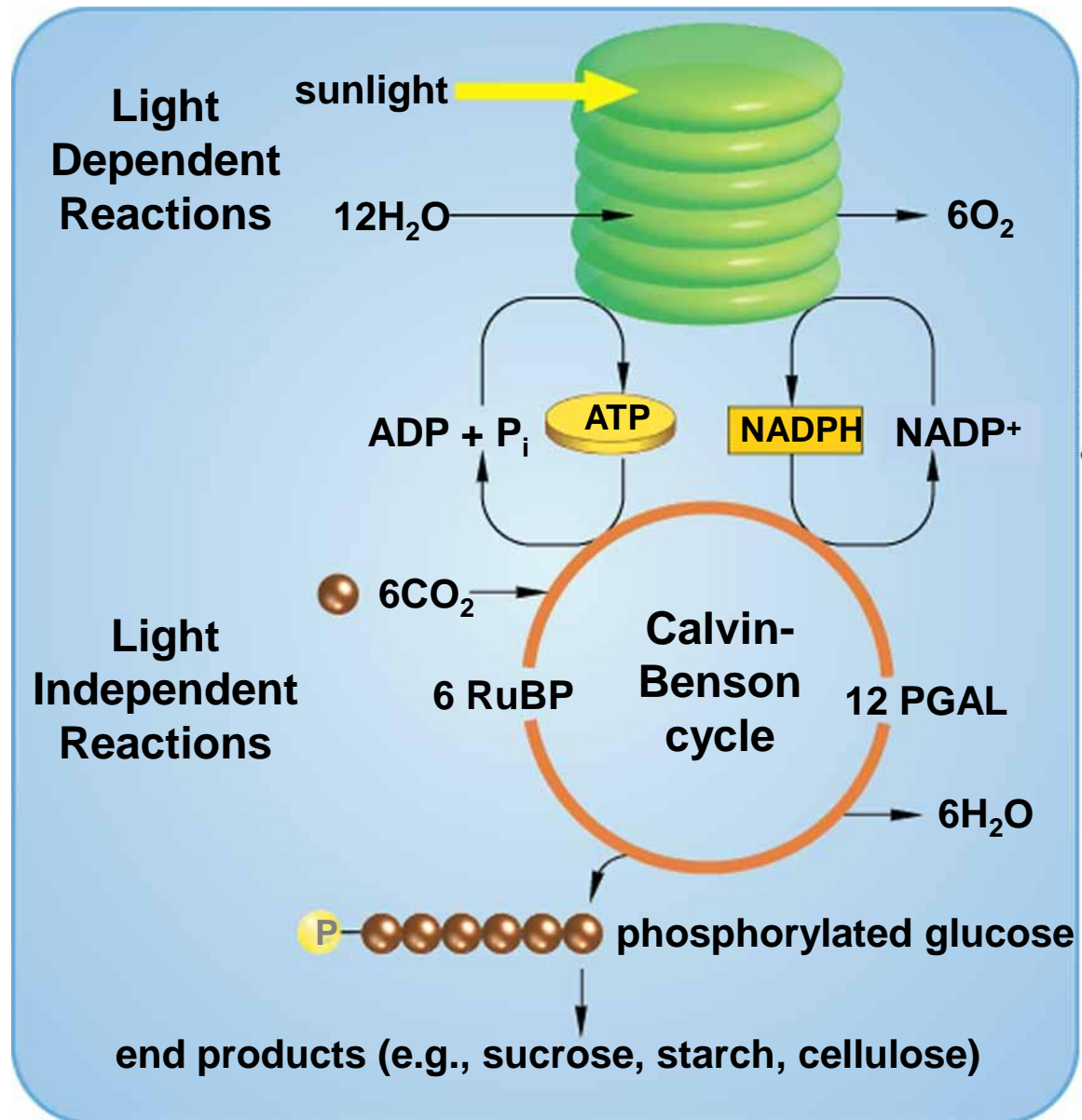


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**Fig. 5-10, p.79**



# Summary of Photosynthesis





# *Carbon and Energy Sources*

---



## ★ Photoautotrophs

- Carbon source is carbon dioxide
- Energy source is sunlight

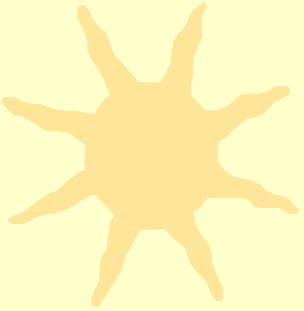
## ★ Heterotrophs

- Get carbon and energy by eating autotrophs or one another



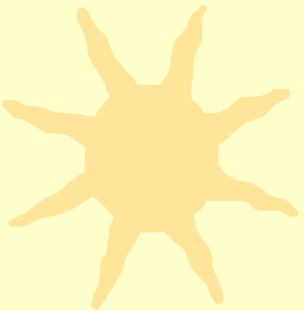
# *Linked Processes*

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## Photosynthesis

- ★ Energy-storing pathway
- ★ Releases oxygen
- ★ Requires carbon dioxide



## Aerobic Respiration

- ★ Energy-releasing pathway
- ★ Requires oxygen
- ★ Releases carbon dioxide

