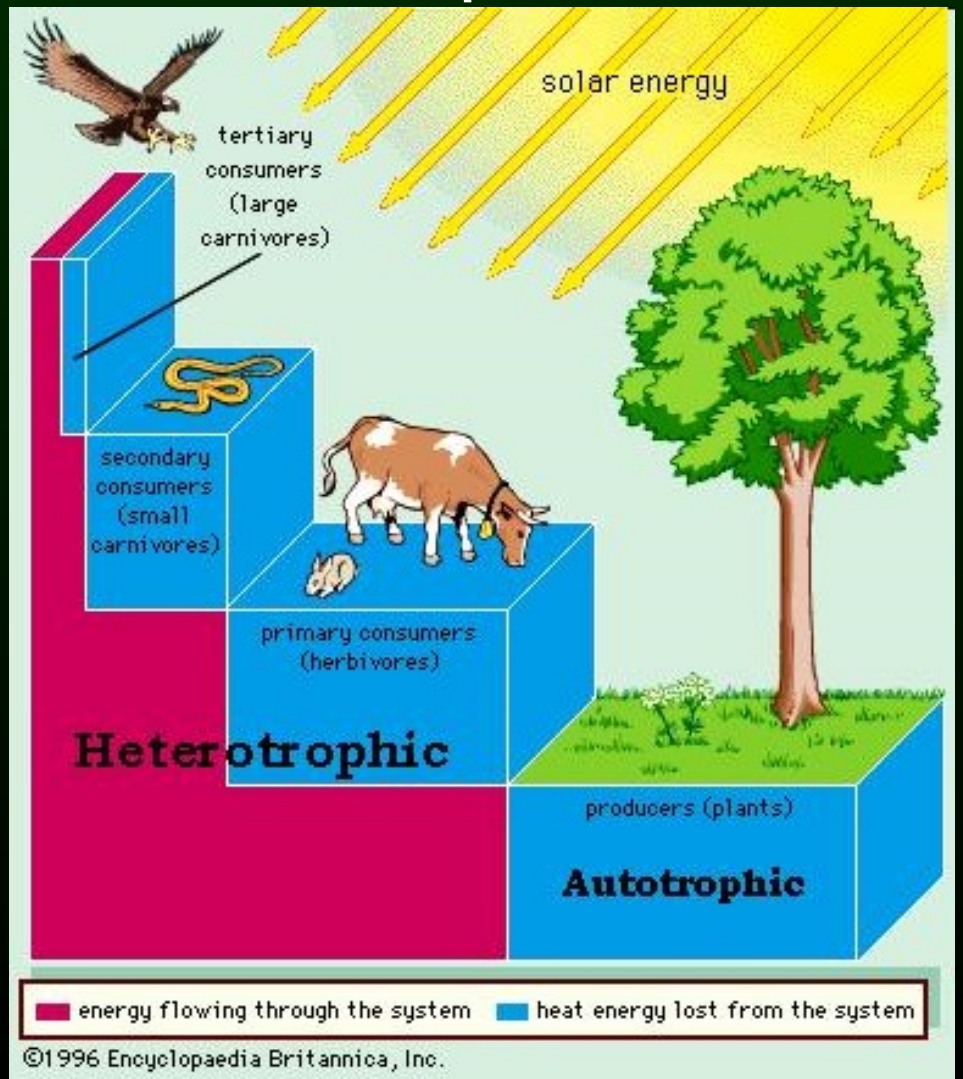
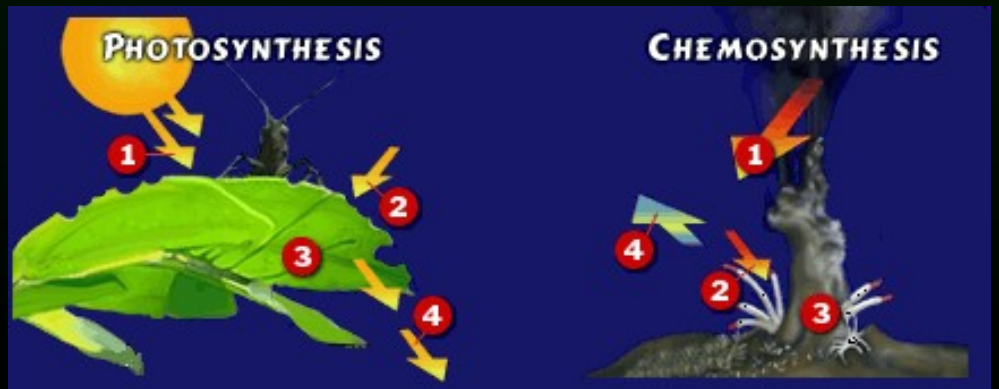
Energy and Nutrient Relations

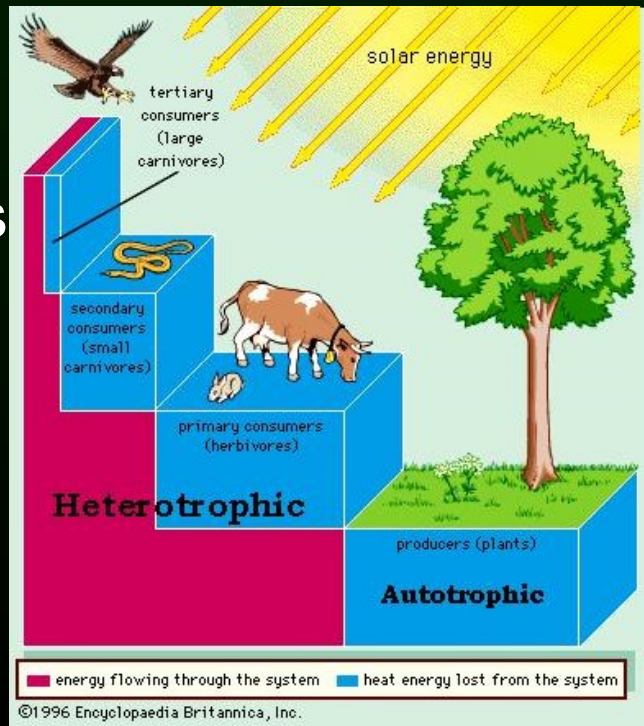
Chapter 7

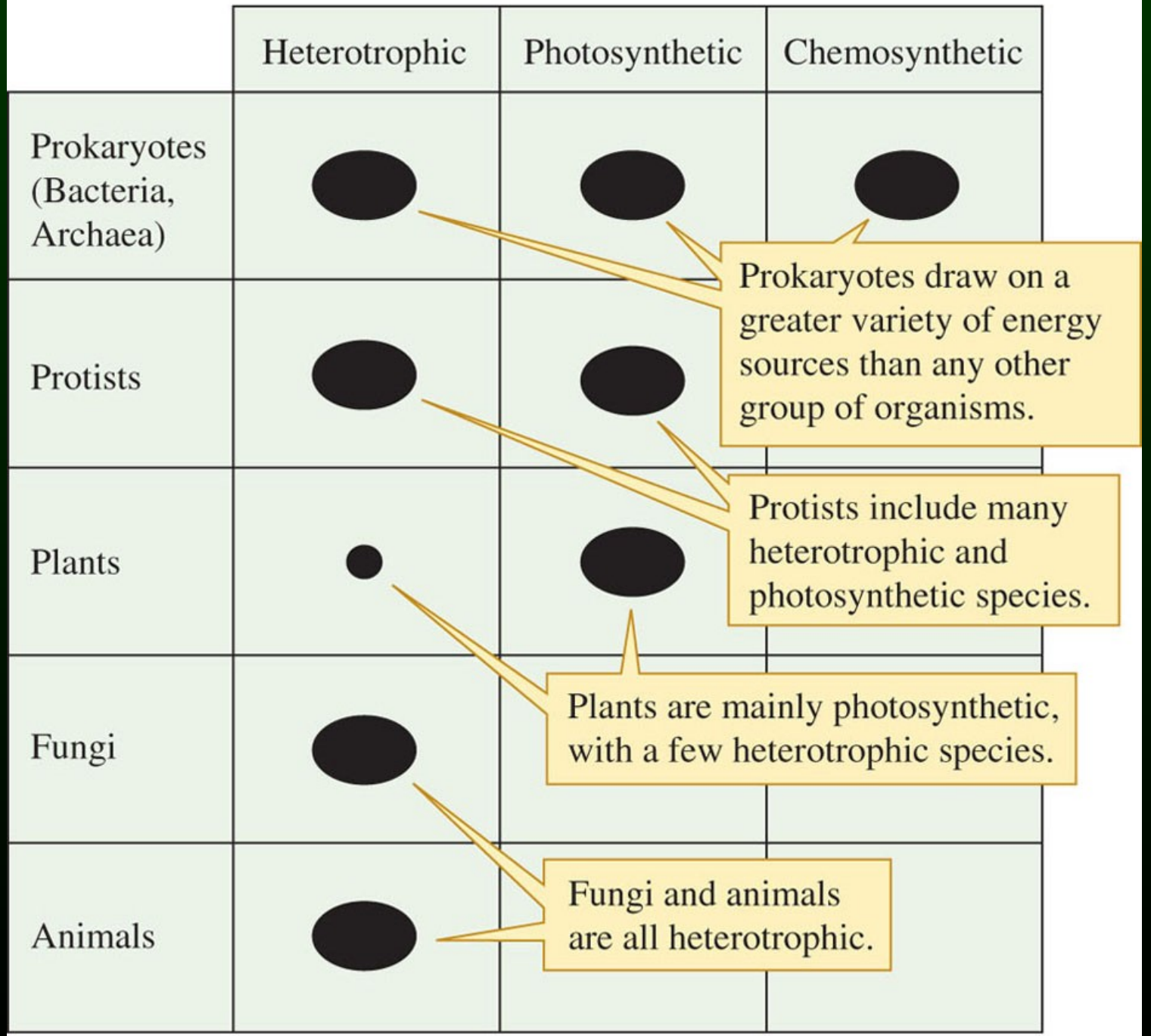


Energy Sources

- Organisms can be classified by trophic (feeding) levels.
  - Autotrophs use inorganic sources of carbon and energy.
    - Photosynthetic: Use CO_2 as carbon source, and sunlight as energy.
    - Chemosynthetic: Use inorganic molecules as source of carbon and energy.
  - Heterotrophs use organic molecules as sources of carbon and energy.



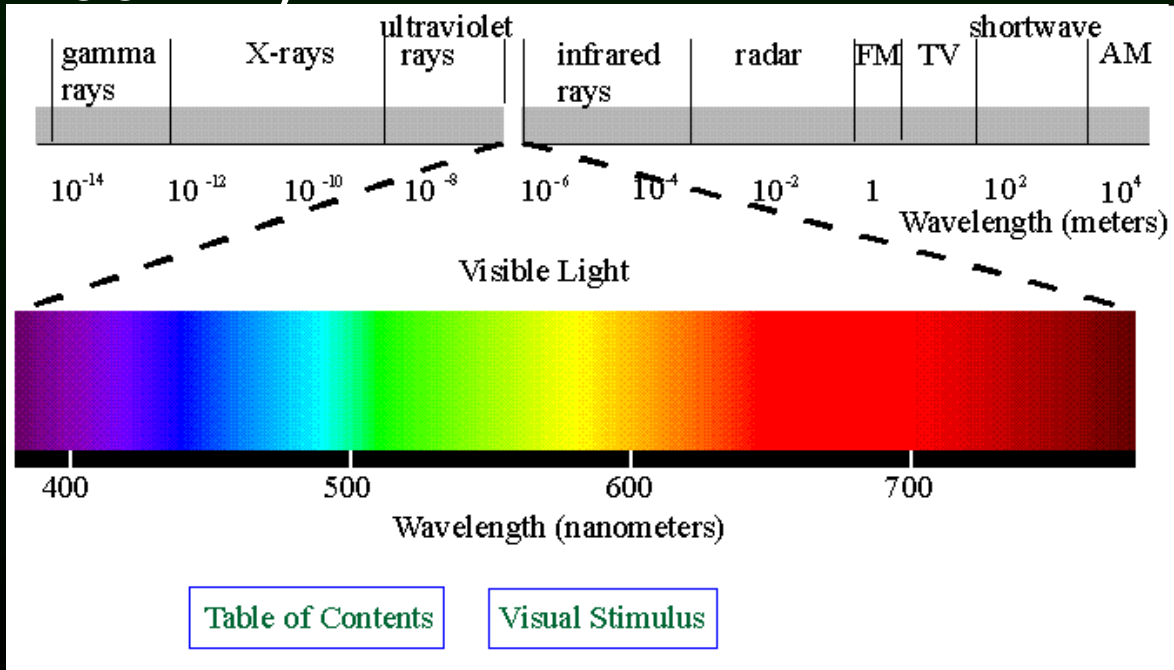




Photosynthesis

- The synthesis of organic molecules using CO_2 as a source of carbon and light as the energy source
  - Light travels in waves in particles called **photons**
  - Photosynthetically Active Radiation (PAR)
    - Wavelengths of light used in photosynthesis (approx. 400-700 nm)

Photosynthesis converts CO_2 to Glucose!



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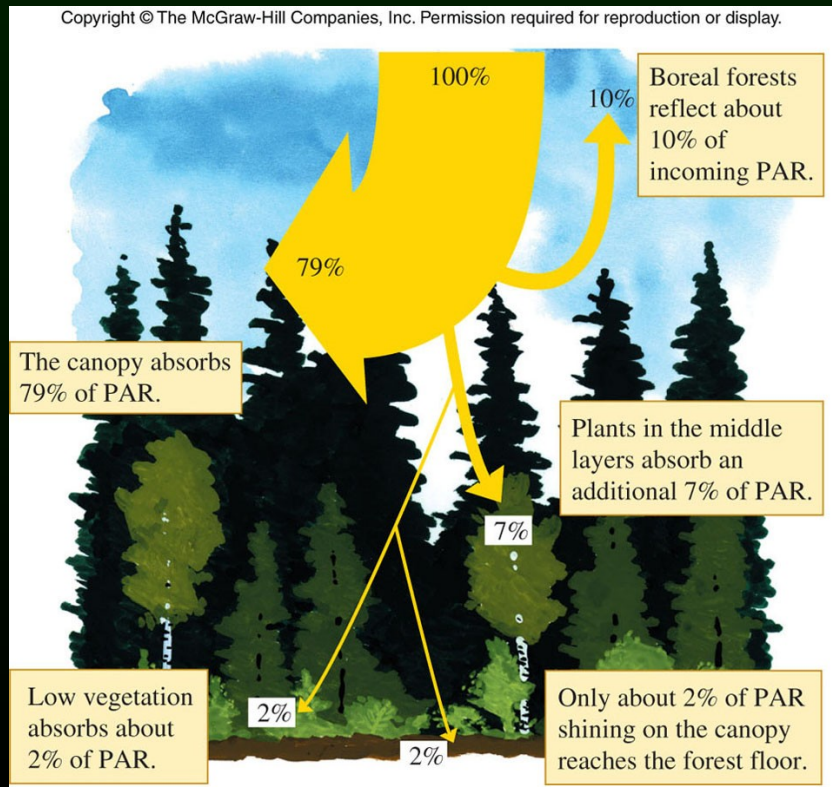
Photosynthesis

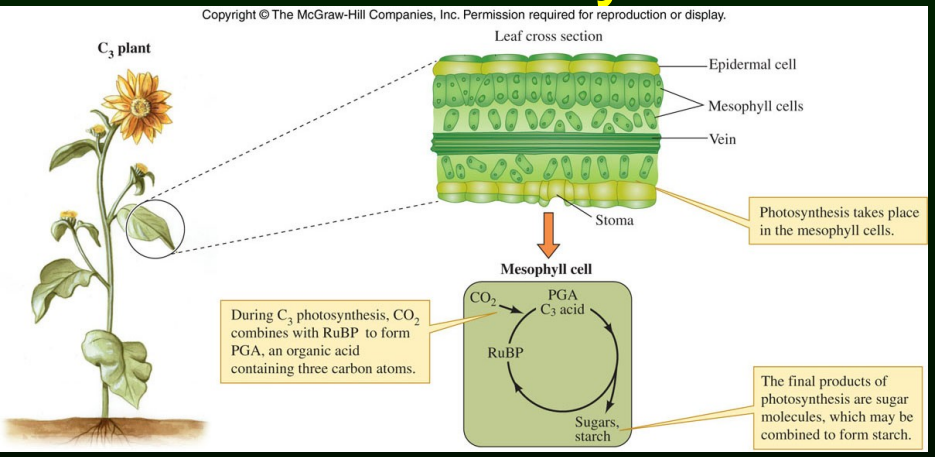
- Chlorophyll absorbs photons.
  - Landscapes, water, and organisms can all change the amount and quality of light reaching an area.

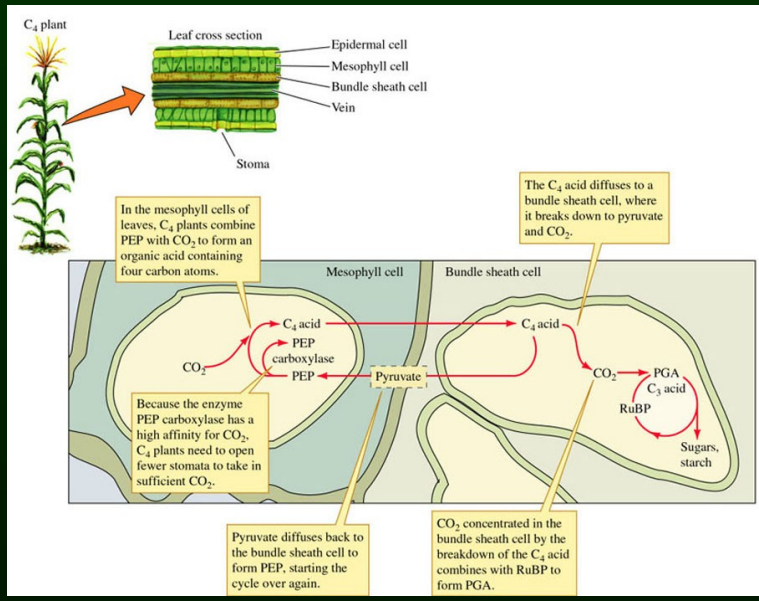
There are different ways that photosynthesizers do it!

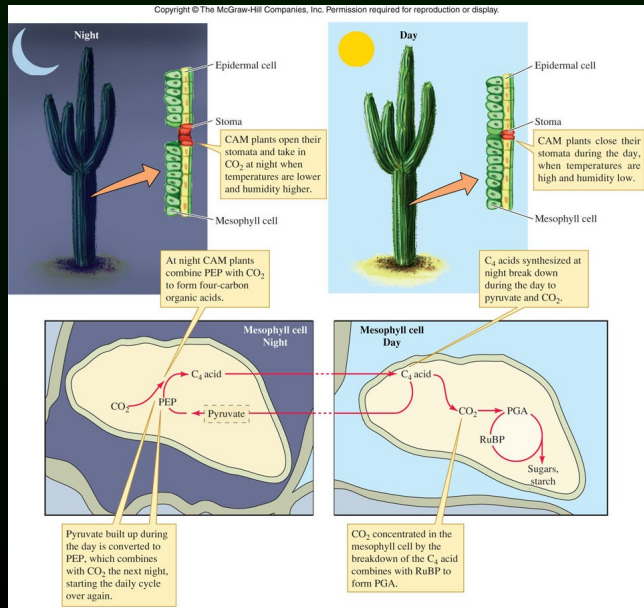


Photosynthetic Pathways

- Three different pathways
  - C_3 Photosynthesis
  - C_4 Photosynthesis
  - CAM Photosynthesis



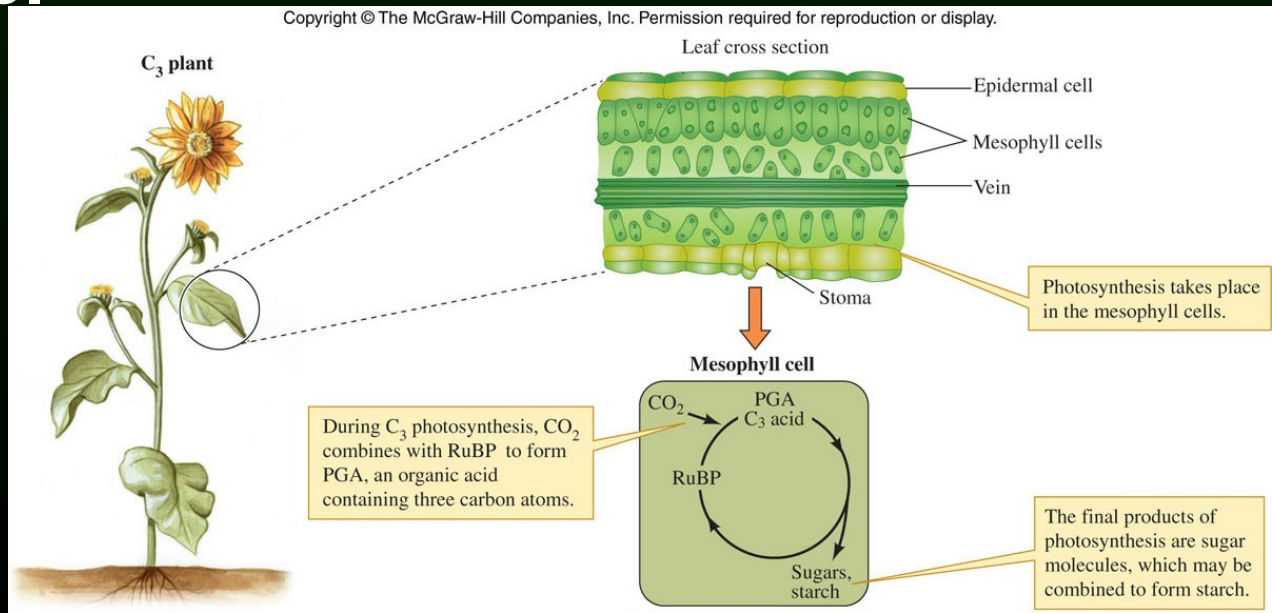




Photosynthetic Pathways - C_3 Photosynthesis

- Used by most plants and algae.
- CO_2 + ribulose bisphosphate (5 carbon sugar) = phosphoglyceric acid (3 carbon acid)
  - To fix carbon, plants must open stomata to let in CO_2 .
    - **Water gradient may allow water to escape.**

Where would you expect to find C_3 plants?



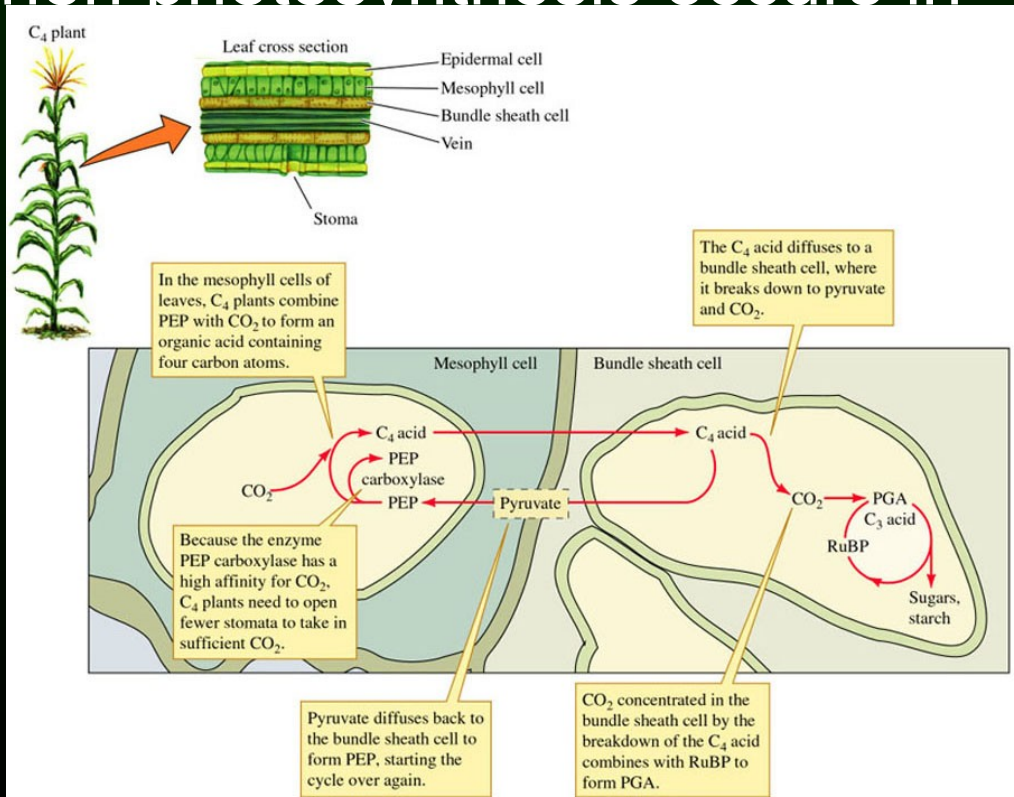
Some C_3 Plants

Wheat, rice, potatoes

Photosynthetic Pathways - C_4 Photosynthesis

- Reduces internal CO_2 concentrations.
  - Increases rate of CO_2 diffusion inward.
  - Need fewer stomata open – **conserves water**!
- Photosynthesis separated in space – C_4 molecule formed in mesophyll, then photosynthesis occurs in bundle sheath cell

Where would you expect to find C_4 plants?

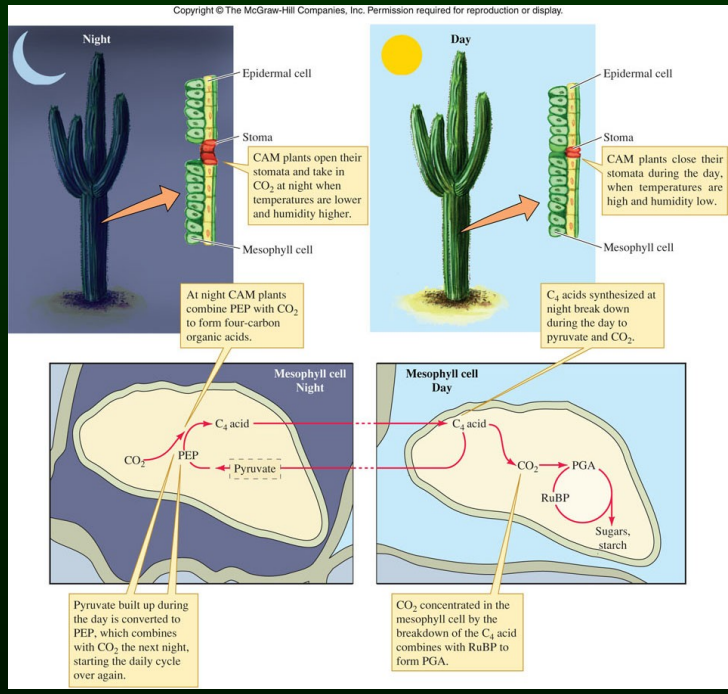


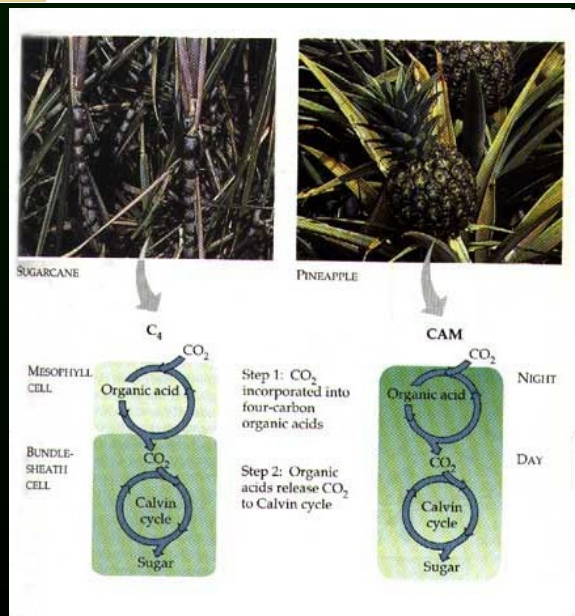
Some C_4 plants

Corn, sugarcane

Photosynthetic Pathways

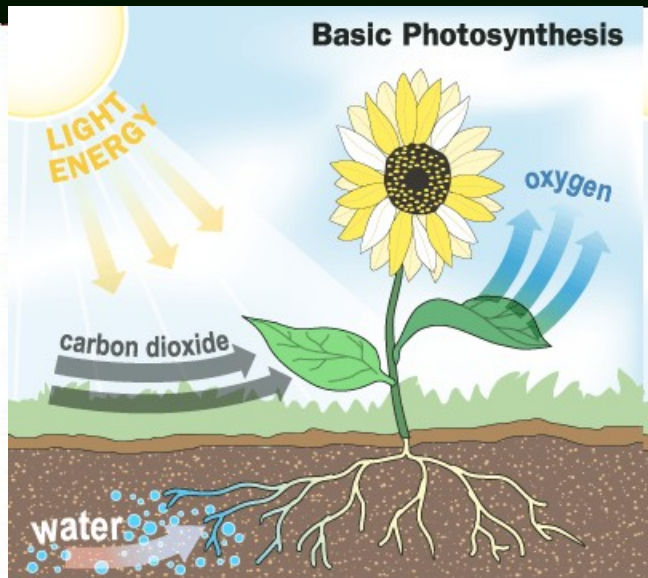
- CAM Photosynthesis
  - (Crassulacean Acid Metabolism)
  - Photosynthesis separated in time
  - Found mainly in succulent (water-storing) plants in arid environments
    - Carbon fixation takes place at night – greatly reduced water loss
    - Low rates of photosynthesis.





Results from the 3 photosynthetic pathways

- C_3 plants lose 380-900 g water for every gram of dry tissue produced
- C_4 plants lose 250-350 g water per gram of tissue produced
- CAM plants lose 50 g water per gram of tissue produced



Chemosynthetic Autotrophs

- Synthesize organic molecules using CO_2 as a carbon source and inorganic molecules as an energy source.
- Discovered in 1977
  - nutrients discharged through oceanic rift.
    - Chemosynthetic bacteria are the autotrophs that the communities depend on.
      - Free-living forms.
      - Living within tissue of invertebrates.

http://www.youtube.com/watch?v=AlHJqA8YkoI

Heterotrophs

- Need to eat other things – source of carbon and energy
- Three Feeding Methods of Heterotrophs:
  - Herbivores: Feed on plants.
  - Carnivores: Feed on animal flesh.
  - Detritivores: Feed on non-living organic matter.

Match 'em!

Chemical Composition and Nutrient Requirements

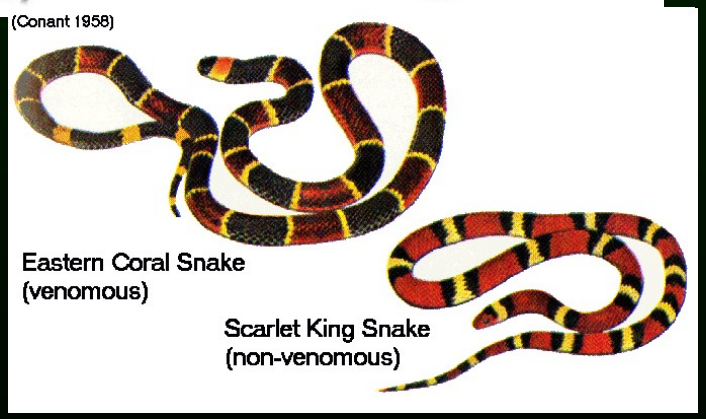
- Five elements make up 93-97% of biomass of plants, animals, fungi and bacteria:
  - Carbon
  - Oxygen
  - Hydrogen
  - Nitrogen
  - Phosphorus

It be dangerous to eat sometimes!!!
Herbivores

- Must overcome plant physical and chemical defenses.
  - Physical
    - Cellulose; lignin; silica
  - Chemical
    - Toxins
    - Digestion Reducing Compounds

It be dangerous to eat sometimes!!!
Carnivores

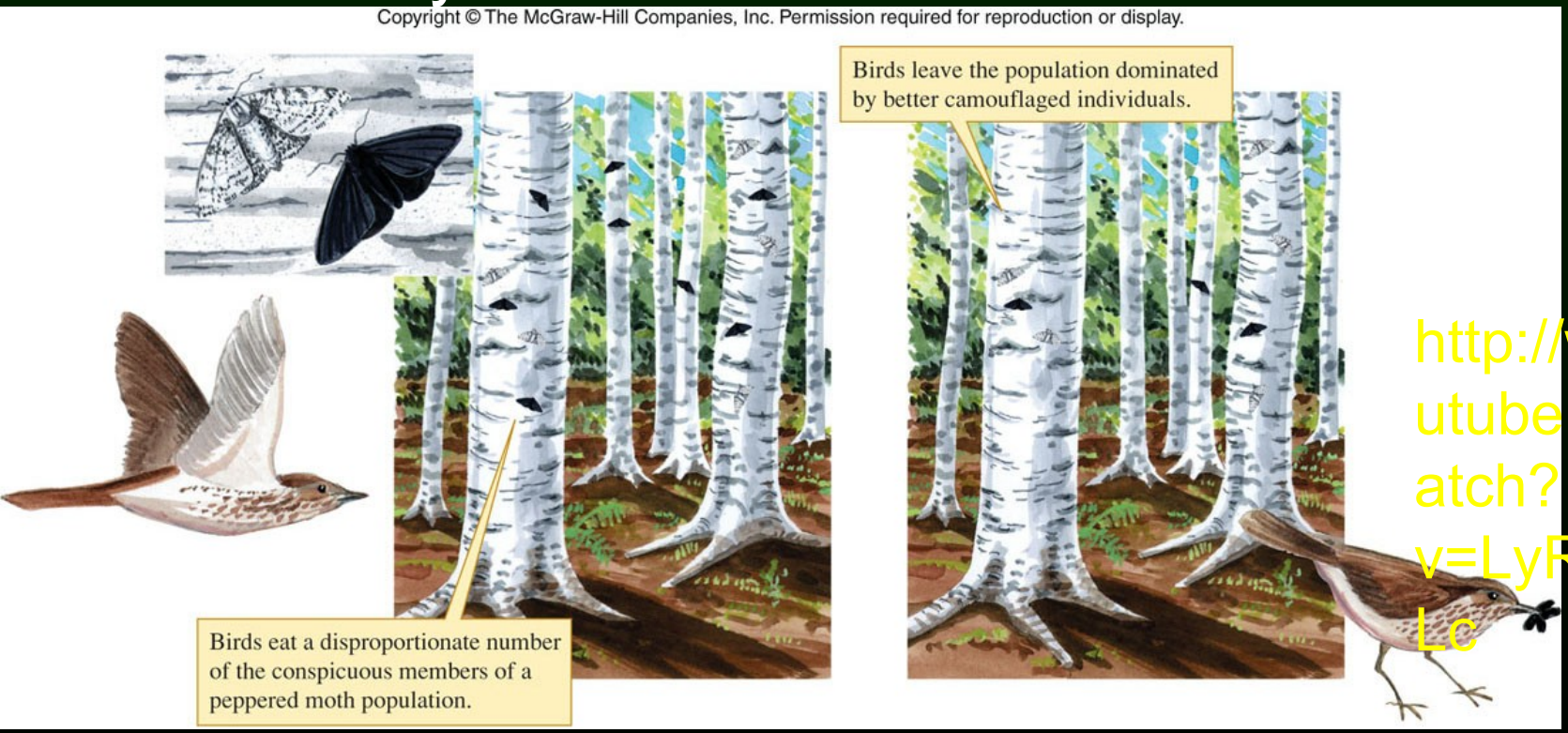
- Prey Defenses:
  - Aposematic Coloring - Warning colors.
  - Mullerian mimicry: Comimicry among several species of noxious organisms.
  - Batesian mimicry: Harmless species mimic noxious species.



http://www.youtube.com/watch?v=lXi1fQ50Bc8

Predators & Prey

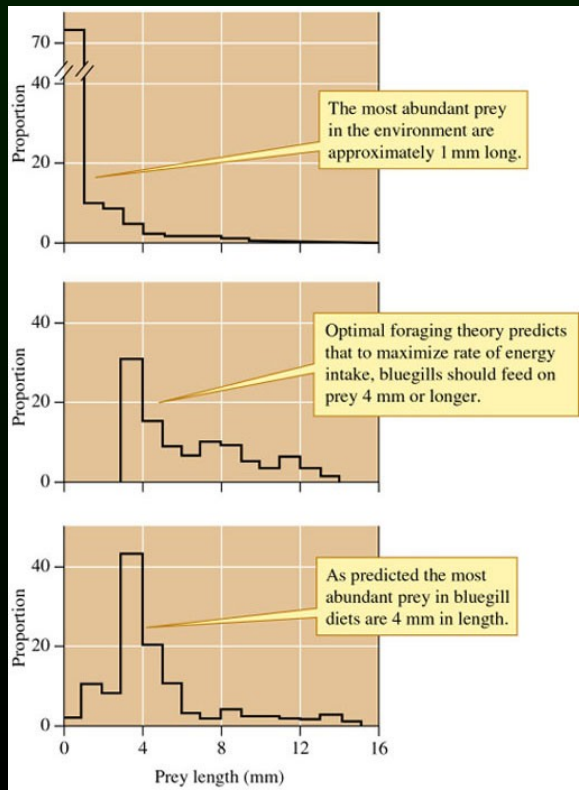
- Predators are usually selection agents for prey
  - Usually eliminate more conspicuous members of a population (less adaptive).
- Predator and prey species are engaged in a co-evolutionary race.



http://www.youtube.com/watch?v=LyRA807djLc

How do organisms choose to eat? Optimal Foraging Theory – Feeding is an optimizing process!

- Natural selection favors individuals within a population that are more effective at acquiring energy
- More abundant/larger prey yields larger energy return.
  - Must consider costs!



http://www.youtube.com/watch?v=d7avgP0IdPQ

Optimal Foraging By Plants???

- Is this possible??? How so???

Plants in environments with abundant nutrients but little light will spend less energy on root growth

Plants in environments with abundant light but poor nutrients will spend less energy on stem and leaf growth