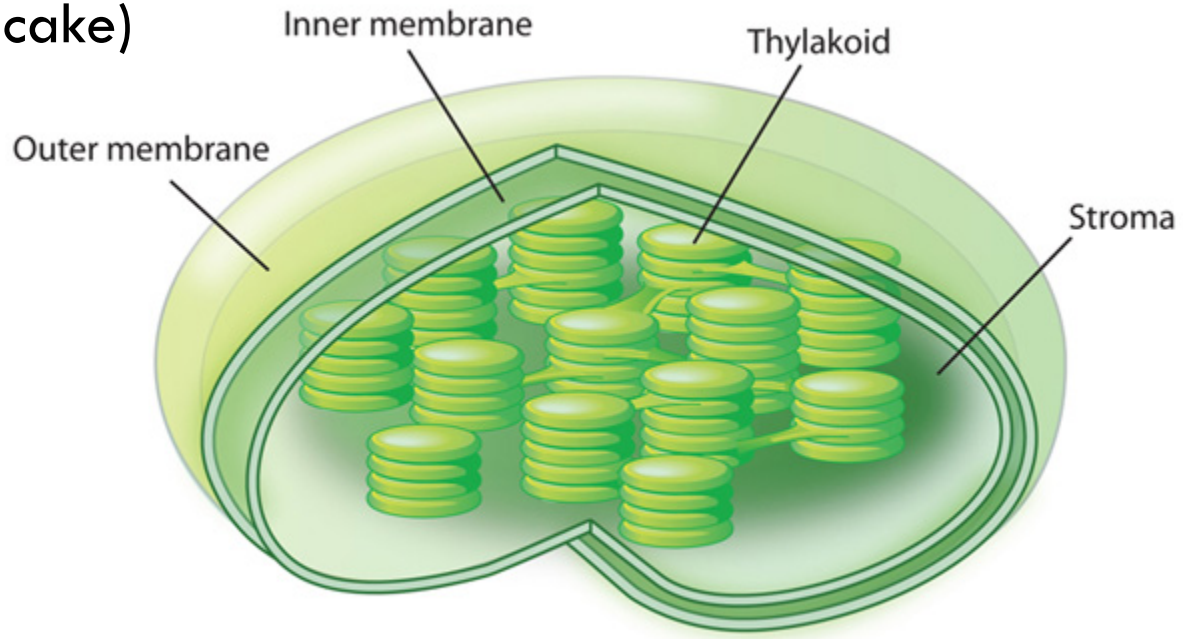
PHOTOSYNTHESIS

Photosynthesis

- Nearly all life depends on E from the sun
- Autotrophs = producers
  - "self feeders"
- Heterotrophs = consumers
  - "other feeders"

Chloroplast

- Structure
  - Double membrane
  - Stroma
  - Grana (short stack)
    - Thylakoid (pancake)
    - Chlorophyll
- Functions
  - Site of photosynthesis
    - Membrane of thylakoid



Photosynthesis overview

Light

$6\ CO_2$

Chlorophyll

$6\ H_2O$

$C_6H_{12}O_6 + 6\ O_2$

(Glucose)

Photosynthesis vs. Respiration

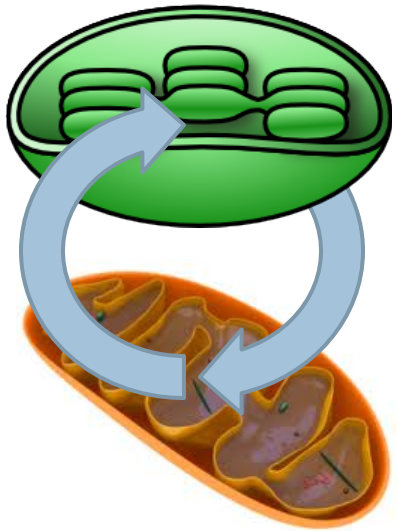
- Respiration
  - E released from sugar
  - e^- lose PE "falling" down ETC
  - Making KE (ATP)
- Photosynthesis
  - Reverses e^- flow
  - Increases PE
  - Requires E_{light}

photosynthesis

$$6CO_2 + 6H_2O + \underbrace{\text{energy}}_{\text{energy in}} \longrightarrow C_6H_{12}O_6 + 6O_2$$

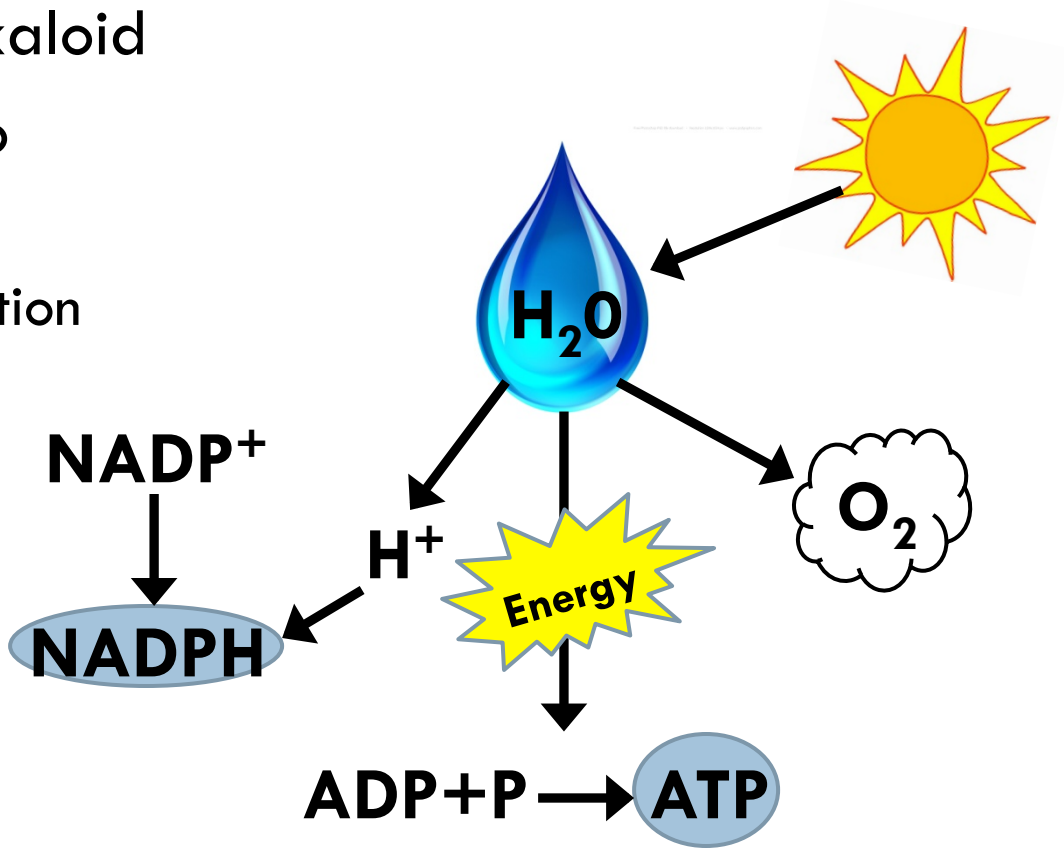
aerobic respiration

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \underbrace{\text{energy}}_{\text{energy out}}$$



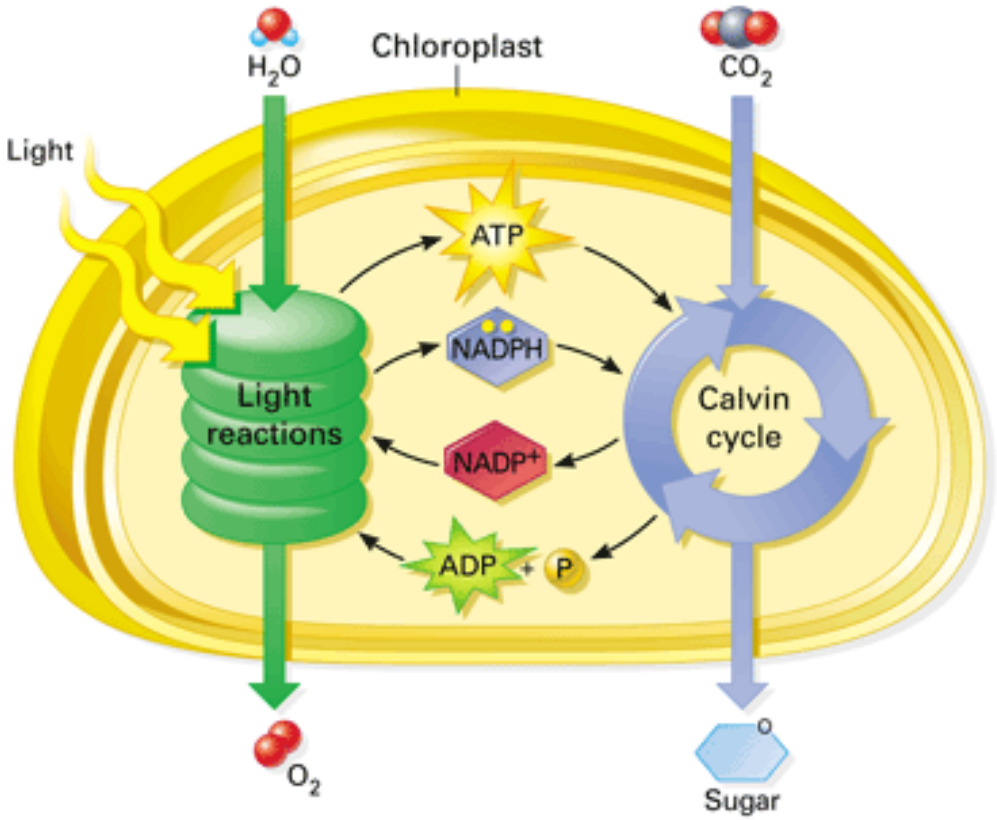
2 Stages of Photosynthesis

- **Light Reactions (Stage 1)**
  - Membrane of thykaloid
  - Converts solar E to chemical E
    - Photophosphorylation
      - ATP synthesis
    - NADPH synthesis



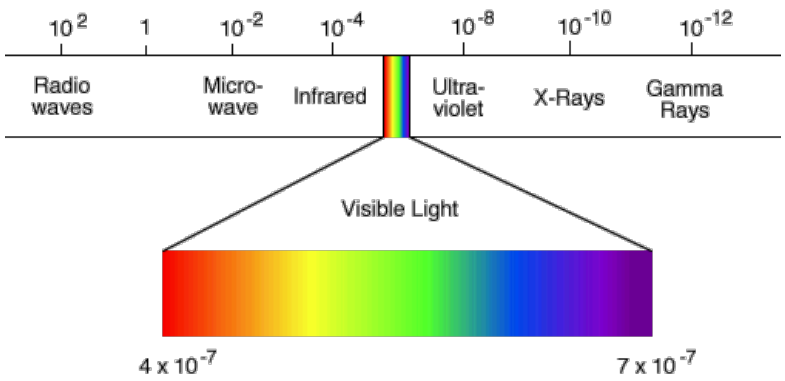
2 Stages of Photosynthesis

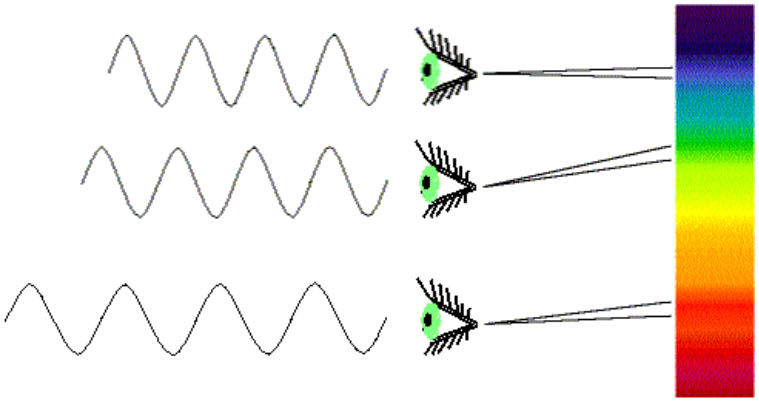
- **Calvin Cycle (Stage 2)**
  - Stroma
  - "Dark" reactions
  - Turns CO_2 into sugar
  - Requires
    - E_{ATP}
    - H^+



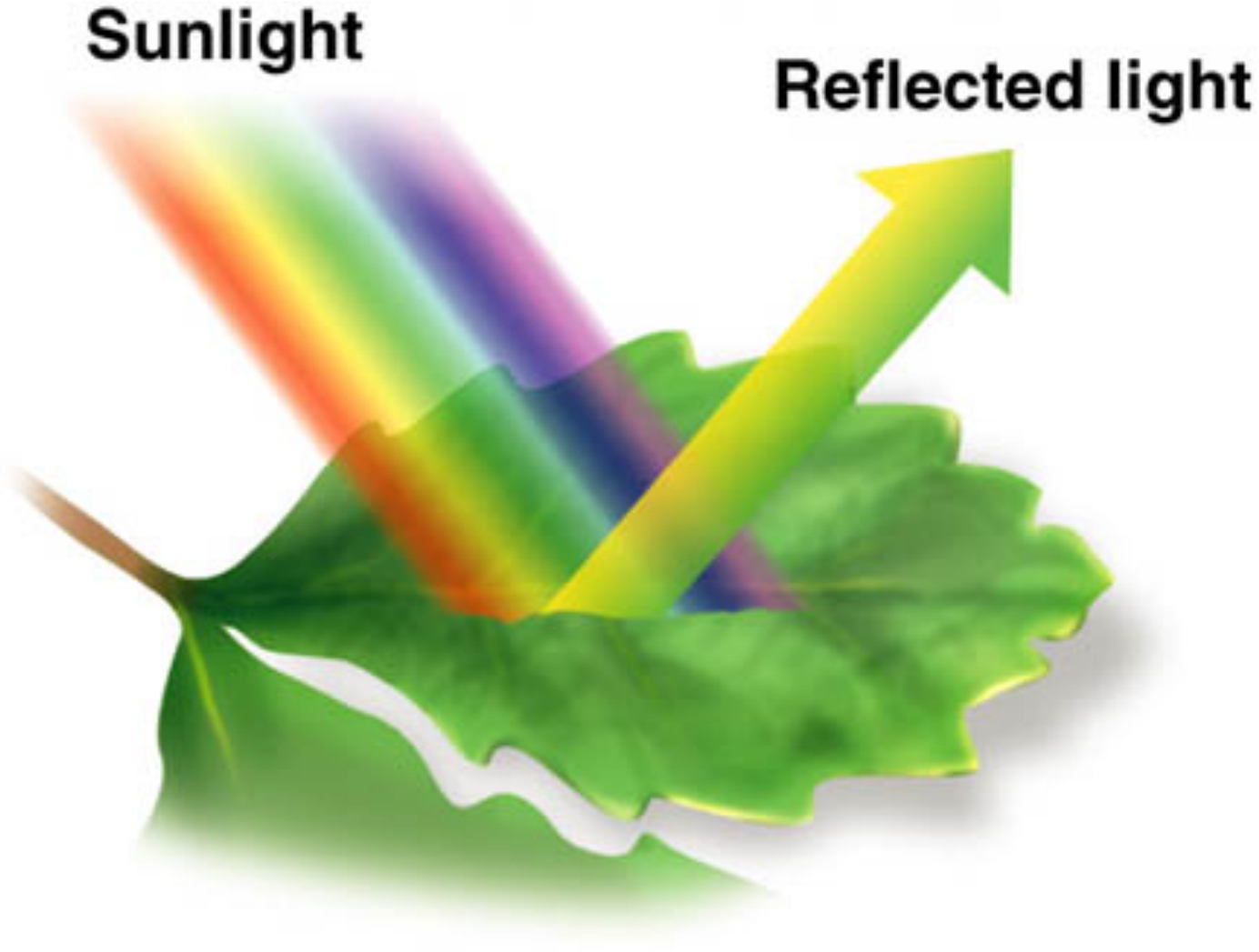
Nature of Light

- Electromagnetic waves
- Visible light most important in photosynthesis
- Color depends on absorption of wavelength
  - Black vs. white



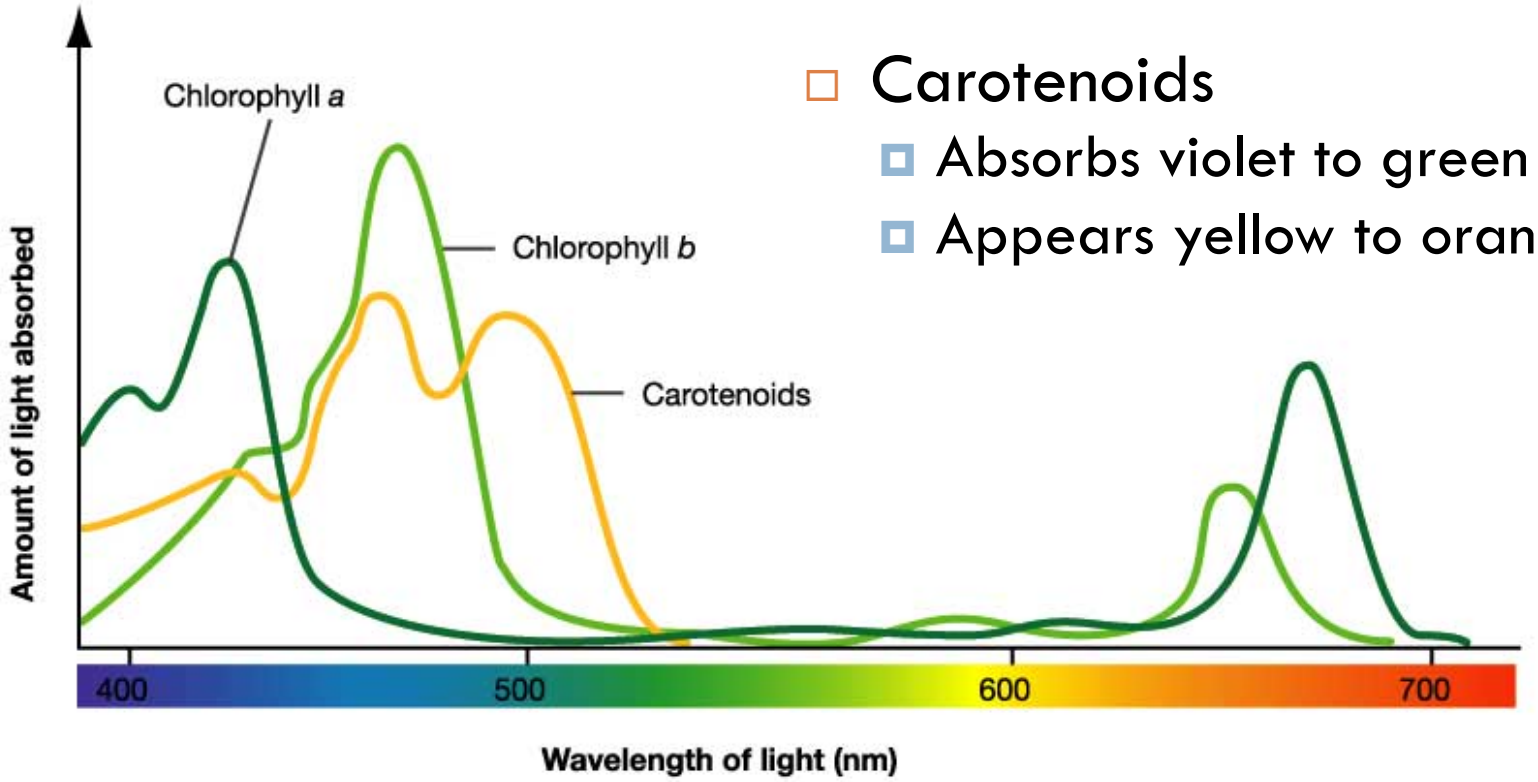


Why are plants green?



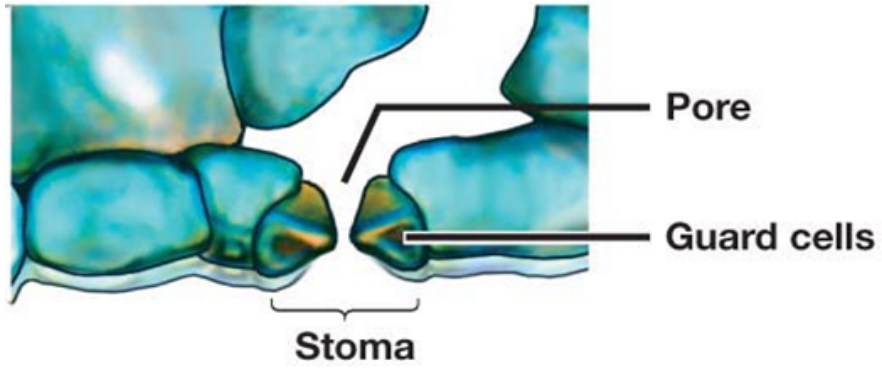
Plant pigments

- Chlorophyll a
  - Absorbs violet-blue & red
  - Appears blue-green
- Chlorophyll b
  - Absorbs blue-green & orange
  - Appears yellow-green
- Carotenoids
  - Absorbs violet to green
  - Appears yellow to orange



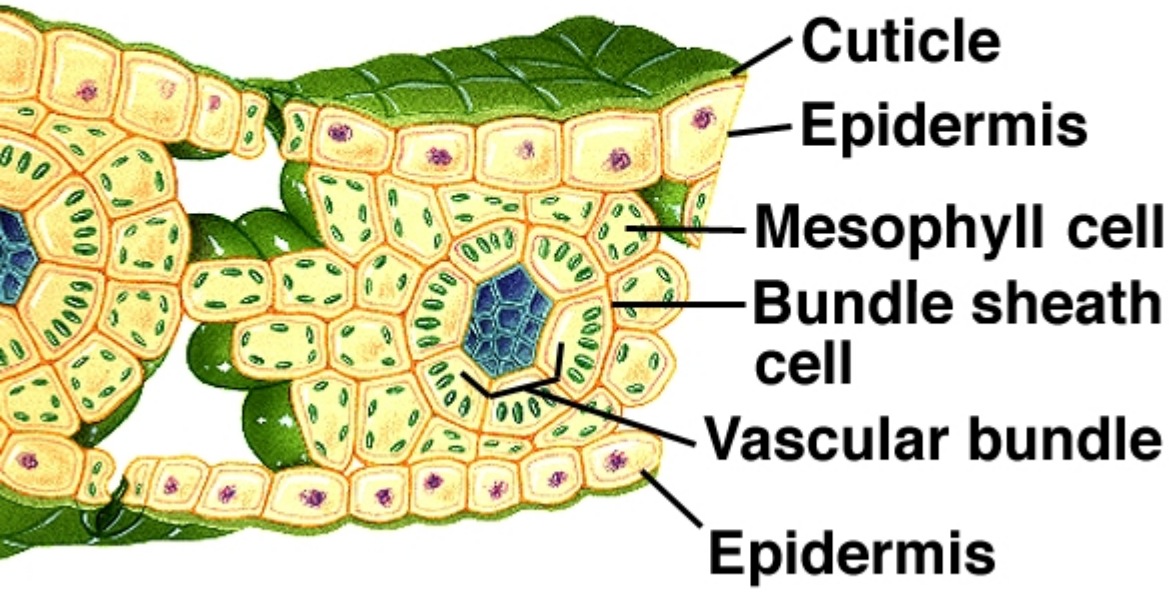
C_3 Plants

- 1st product of light reaction
  - 3 Carbon molecule
- Hot, dry days
  - Stomata close
- Advantage
  - Conserves water
- Disadvantage
  - No CO_2 in
  - Photorespiration
    - O_2 into Calvin Cycle
    - Produces no sugar & uses ATP



C_4 Plants

- 1st product of light reactions
  - 4 Carbon molecule
- Spatial separation of PS steps
  - C-fixation in mesophyll
  - Calvin Cycle in bundle sheath cell
    - Advantages
      - Minimizes photorespiration
      - Enhances sugar production
      - Hot, intense sun
    - Disadvantage
      - Requires more ATP



CAM Plants

- Crassulacean Acid Metabolism
  - e.g. succulent plants
- Temporal separation of PS Steps
  - Night: Carbon fixation
  - Day: Calvin Cycle
- Advantages
  - Less water loss through stomata
- Disadvantages
  - Limited amount of CO_2