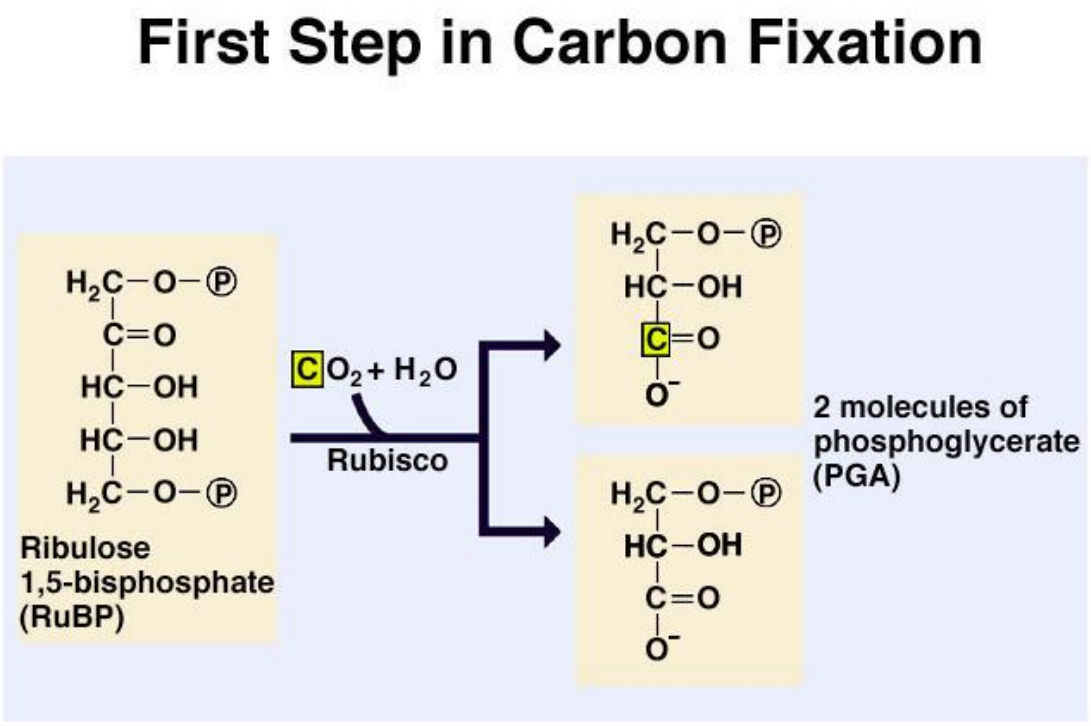
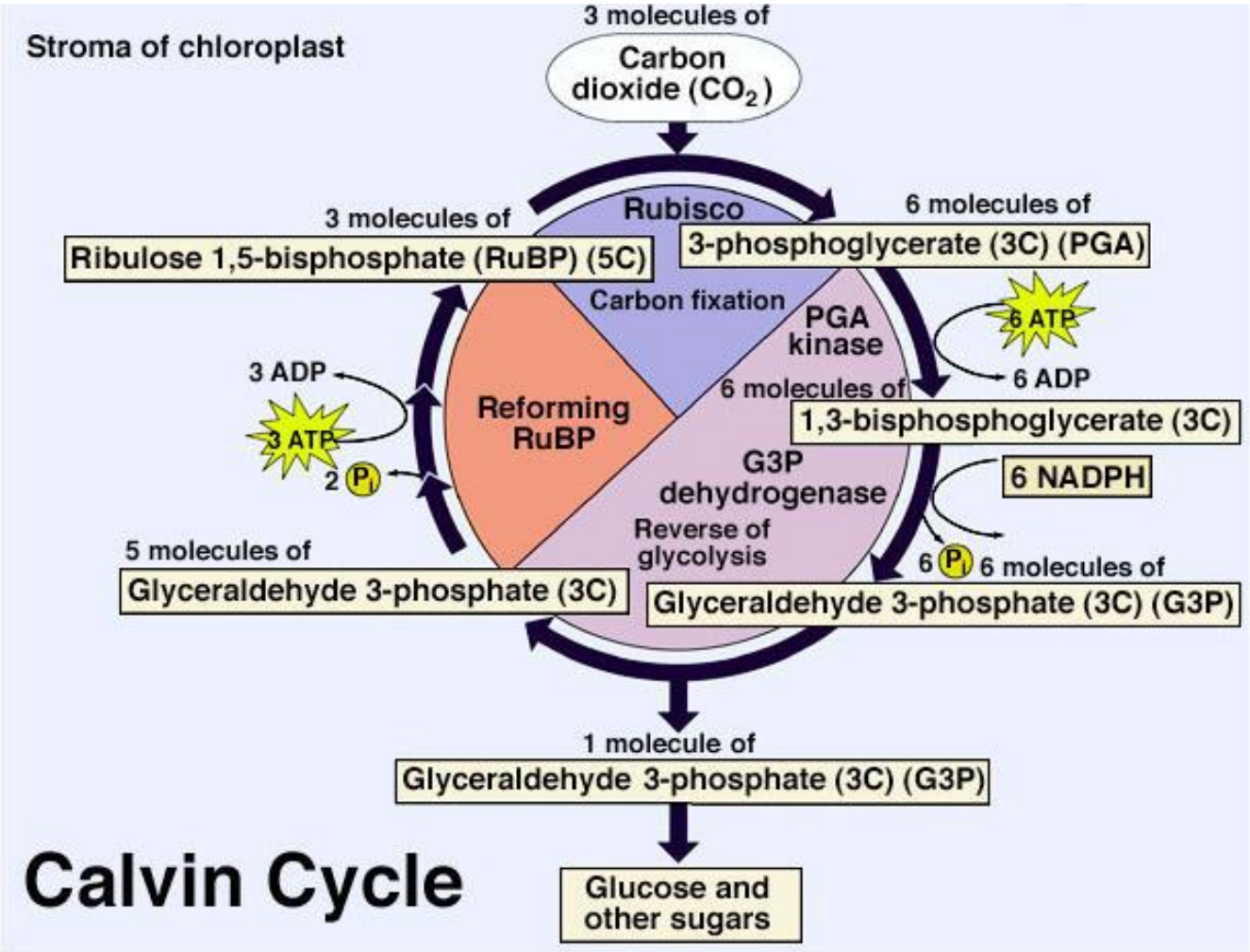
Photosynthesis

Dark Light Independent Reactions:

- **2 Main Steps**
  - Carbon Dioxide Fixation
  - Sugar Formation
- Occur in the Stroma of the Chloroplasts
- Do not Require Light Energy to Occur
- Ribulose bisphosphate carboxylase oxygenase (Rubisco) fixes CO2 & O2 is Enzyme in Calvin Cycle (1st step), Most abundant protein on Earth
  - 25% total leaf protein





Model of Carbon Dioxide Fixation

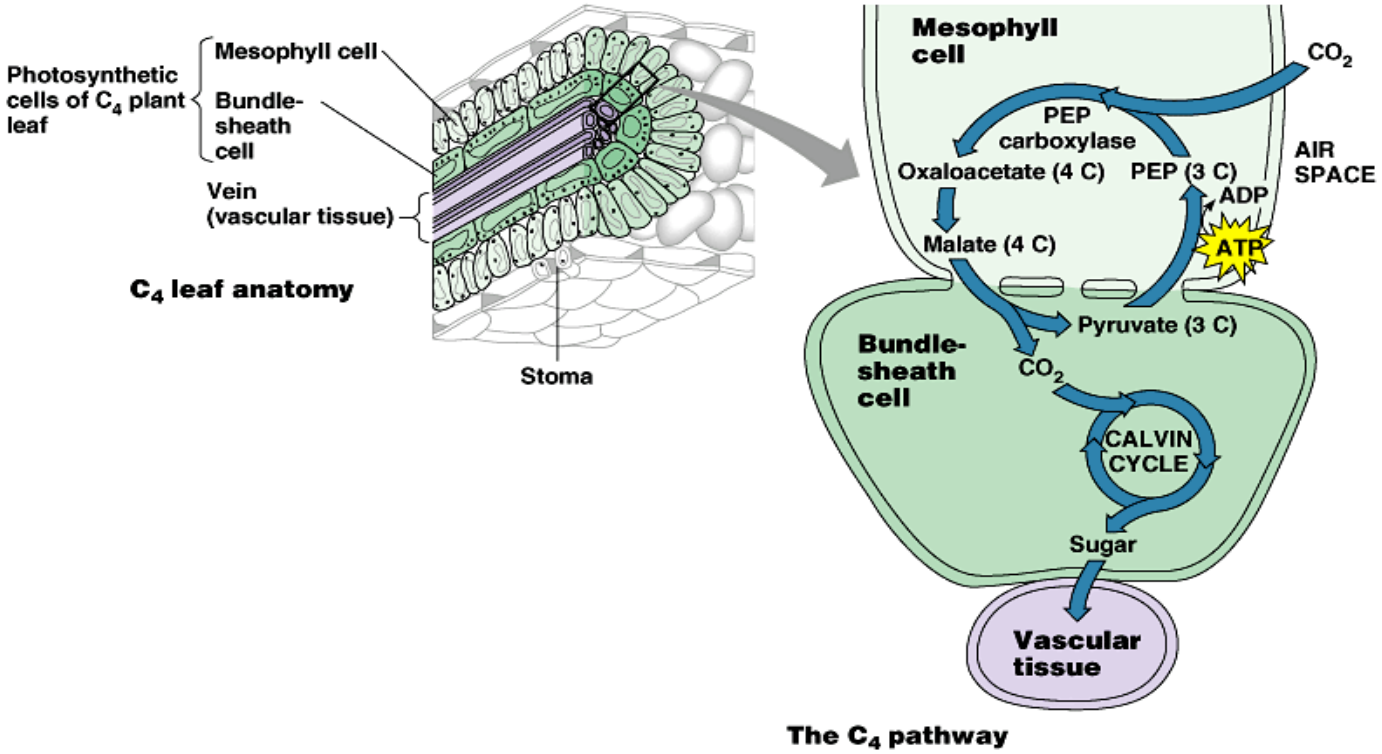
1- C_3 Plants

- Use an Enzyme Called RuBP Carboxylase (RuBisCo) to Carry out the CO_2 Fixation
- This Occurs in the Mesophyll Cells
  - Palisade or Spongy
- Creates a 3-Carbon Product Ready for Sugar Formation
- Called C_3 Plants because the 1st Stable Carbon Chain Made from CO_2 Has 3 Carbons
- C_3 Crops
  - Wheat, Soybeans, Cotton, Tobacco, Small Grains, Legumes, Tomatoes, Potatoes, Peppers, Cucurbits

2- C_4 Plants

- 'Hatch-Slack Pathway'
- Process of CO_2 Fixation for many Plants of Dry or Tropical Origins
- Plants Use a Different Enzyme Called PEP in the Mesophyll Cells for CO_2 Fixation
  - PEP Carboxylase Has a much Higher Affinity for CO_2 than Does Rubisco
  - At Low CO_2 Pressures, Rubisco Doesn't Distinguish Well between O_2 and CO_2 so Stomata usually Have to Be Wide Open for PS to Occur
- Creates a 4-Carbon Product

- This 4-Carbon Chain Is then Transported into Bundle Sheath Cells where the CO_2 Is Released and then Immediately Fixed by Rubisco as Part of the C_3 Cycle
  - Bundle Sheath Cells Are Specialized Cells that Surround the Vascular Bundles in the Leaves
- Same Fixation with Rubisco as in C_3 Plants but Occurs in the Bundle Sheath Cells, not Mesophyll Cells.



CAM Photosynthesis

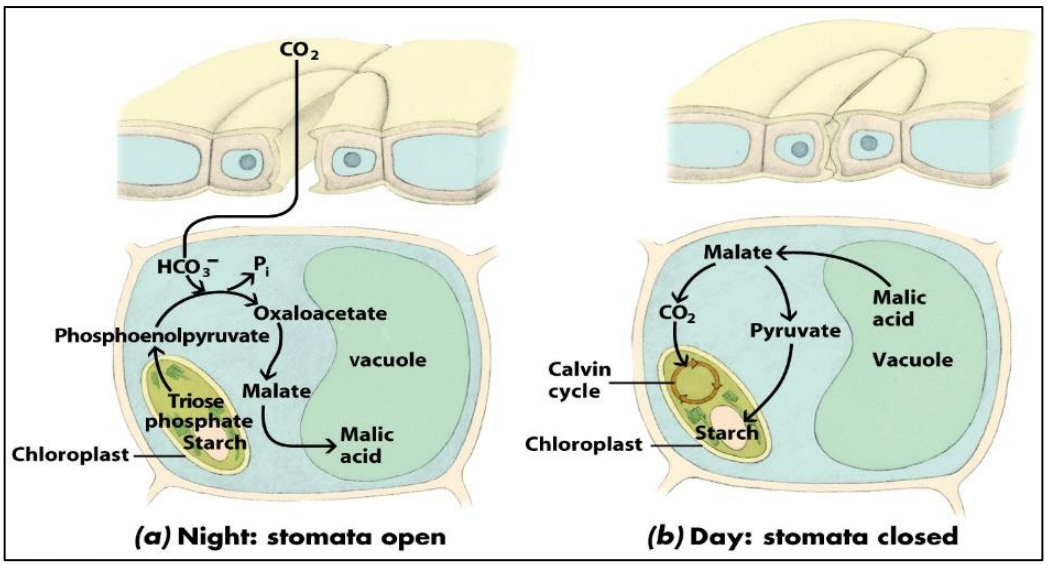
- Crassulacean Acid Metabolism:
- Another Type of PS Carried out only by Xerophytes (cactus and ice plants)
- Hot, dry environments.
- At Night
  - Stomata Are Open
  - Plants Fix CO_2 into a 4-Carbon Product
  - 4-Carbon Product Stored overnight in Vacuole
- At Day

- Stomates closed.

- Light rxn - occurs.

- Calvin Cycle - occurs when CO_2 is present.

CAM plants

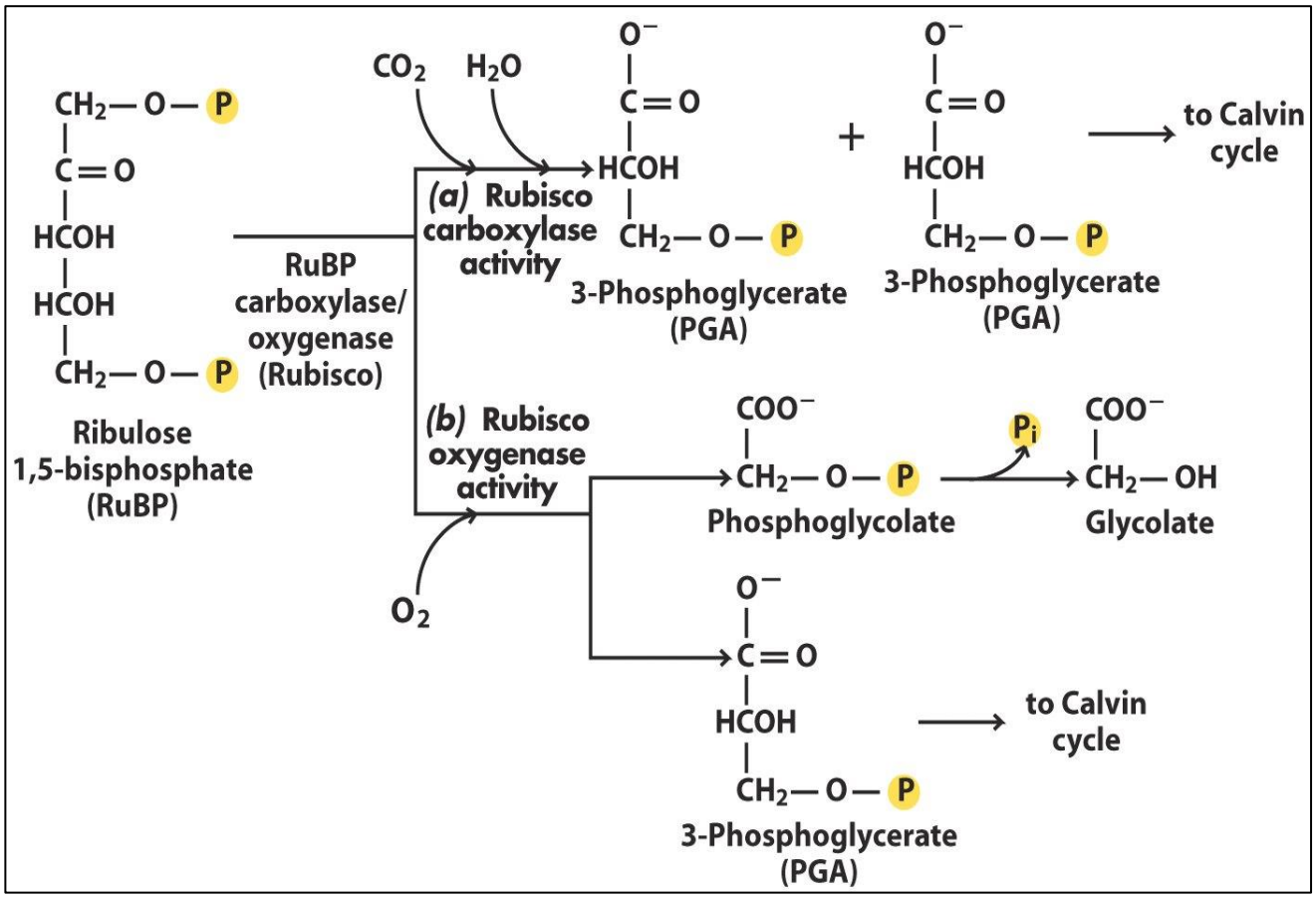


PEP Carboxylase vs. Rubisco

PEP carboxylase works well at warm temperatures but not optimally at cool temps. This is the reason why C4 grasses are referred to as warm season grasses, and why they don't compete well with C3 grasses at cooler temps. C4 grasses have an edge in dry warm sites or open sunny sites as they can keep leaf stomata closed during mid-day and extract every last CO_2 molecule in the leaf. In contrast, C3 grasses that keep stomata closed in dry sunny sites undergo high amounts of respiration.

Photorespiration

- In the "normal" reaction, CO_2 is joined with RUBP to form 2 molecules of 3PGA
- In the process called **photorespiration**, O_2 replaces CO_2 in a non-productive, wasteful reaction. Less ATP Is Produced from the Photorespiration
- The appearance of C4-type plants appears to be an evolutionary mechanism by which photorespiration is suppressed.



Light Compensation Point:

- Level of Light Intensity where the Rate of Respiration (CO_2 Produced) Equals the Rate of PS (CO_2 Consumed).
- Greater Light Intensity should Result in Net Dry Matter (Carbohydrate Accumulation).
- Lower Light Intensity will Result in Net Dry Matter Loss over Time.