CONCEPT: LIGHT INDEPENDENT REACTIONS (CALVIN CYCLE)

Carbon Fixation (Calvin Cycle)

● **Carbon fixation** uses ATP and NADPH to fix carbon from CO_2 in order to create sugar in C3 plants (majority of plants)

□ CO_2 is attached to ribulose 1,5 bisphosphate (5 carbon sugar)

- Creates two 3-phosphoglycerates (two three carbon sugars) (Step 1)

- Reduced to form glyceraldehyde 3-phosphate (Step 2)

- Releases O_2 as _____ product

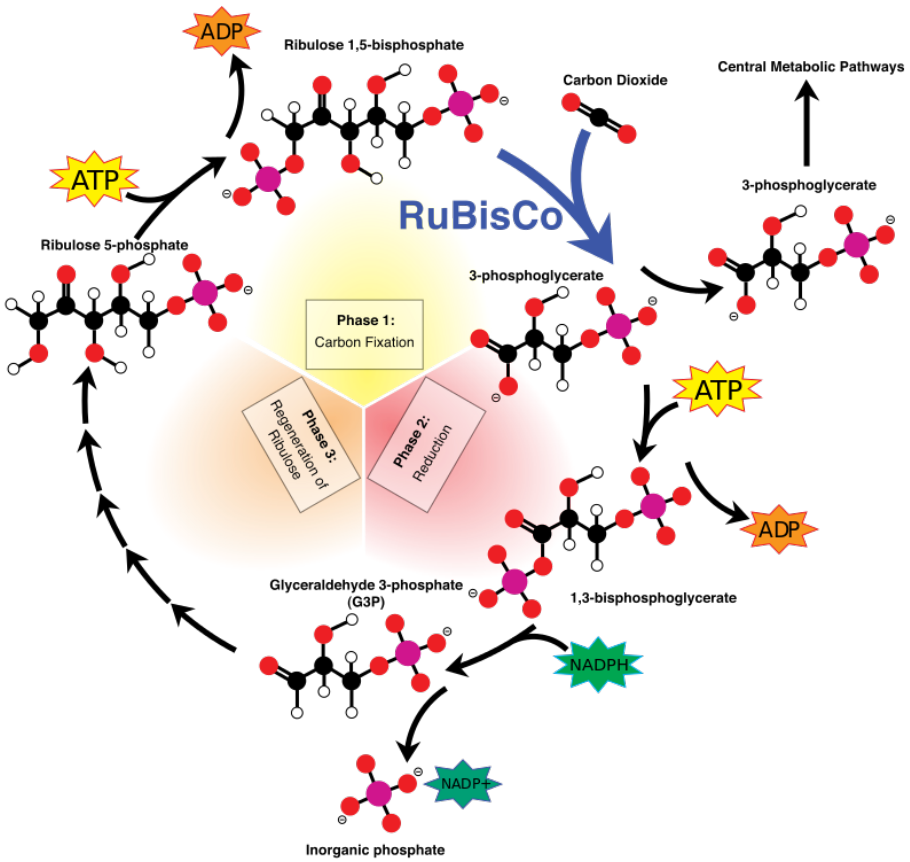
□ **RUBISCO** (ribulose bisphophate carboxylase) catalyzes carbon fixation

- Works slowly – so plants need a lot of it (most abundant protein on earth)

□ ATP and NADPH are used to generate more ribulose 1,5 bisphosphate (Step 3)

□ 3 CO_2 makes one glyceraldehyde 3-phosphate _____ 9 ATP and 6 NADPH

EXAMPLE: Overview of the Calvin Cycle



● Once the glyceraldehyde 3-phosphate is created it can be used in a number of ways

□ Converted into starch

□ Used in glycolysis to create ATP

□ Made into sucrose or other sugars

Carbon Fixation in C4 and CAM Plants

● Carbon fixation that occurs in C3 plants (most plants) is not efficient in _____ environments

□ **Stroma** (pores) in the plant leaves _____ when its hot to prevent loss of water

- Unfortunately, this prevents gas exchange (entering of CO_2 into the plant) causing build up of O_2

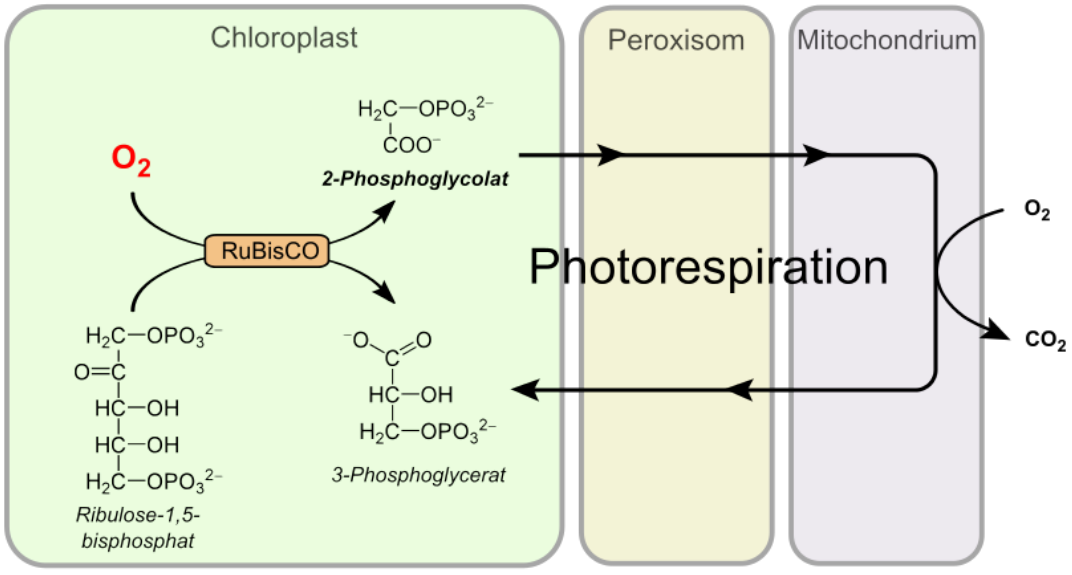
□ **RUBISCO** can bind to CO_2 or O_2 – each produces a different product

- CO_2: Produces glyceraldehyde 3-phosphate – photosynthesis

- O_2: Produces phosphoglycolate – photorespiration (big waste of plant energy)

□ ATP and NADPH are used to generate more ribulose 1,5 bisphosphate (Step 3)

EXAMPLE: Photorespiration in plant cells



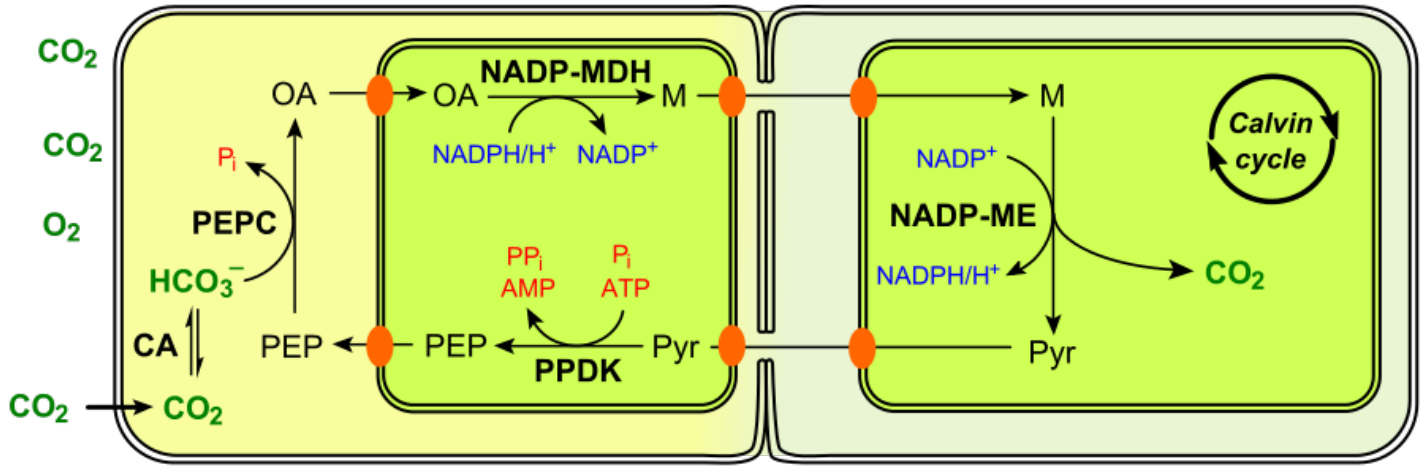
● **C4 plants** (corn, certain types of grasses) handle O_2 build up by physically separating carbon fixation reactions

□ Mesophyll cells – light-dependent reaction and fixation of CO_2 to malate molecule

□ Bundle sheath cells – CO_2 is released from malate and continues along the C3 Calvin cycle pathway

- RUBISCO is isolated from accumulation of O_2 to prevent wasting energy on photorespiration

EXAMPLE: C4 photosynthesis pathway



● **CAM plants** (cacti) handle O_2 build up by differentially controlling CO_2 at different points in the day

□ At night, when it is cool the stroma is open

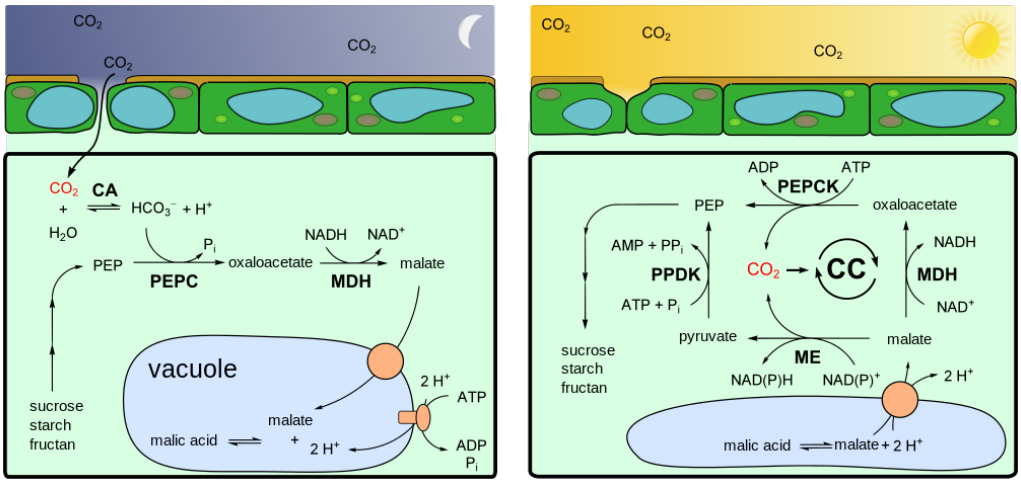
- CO_2 is fixed using RUBISCO and the C3 pathways

□ In daytime, when it is hot the stroma is closed

- CO_2 is fixed to malate and stored in a vacuole

- When the stroma closes CO_2-malates leaves the vacuole, is released and fixed by RUBISCO

EXAMPLE: Transition between day and night in CAM plants



PRACTICE:

1. What is the function of RUBISCO in carbon fixation?
    a. Catalyzes carbon fixation
    b. Convert carbon into starch
    c. Promoting gas exchange
    d. Opening and closing the stroma

2. Why does the Calvin cycle require light?
    a. Because light forms ATP through the light dependent reactions
    b. Because light forms NADPH through the light dependent reactions
    c. Because light forms CO_2 through the light dependent reactions
    d. Because light forms O_2 through the light dependent reactions

3. How many molecules of CO_2 are required to create one glyceraldehyde 3-phosphate?
    a. 1
    b. 2
    c. 3
    d. 4

4. True or False: RUBISCO only binds to CO_2.
    a. True
    b. False

5. Which of the following plants handles O_2 buildup by physically separating RUBISCO from O_2?
    a. C3 Plants
    b. C4 Plants
    c. CAM Plants