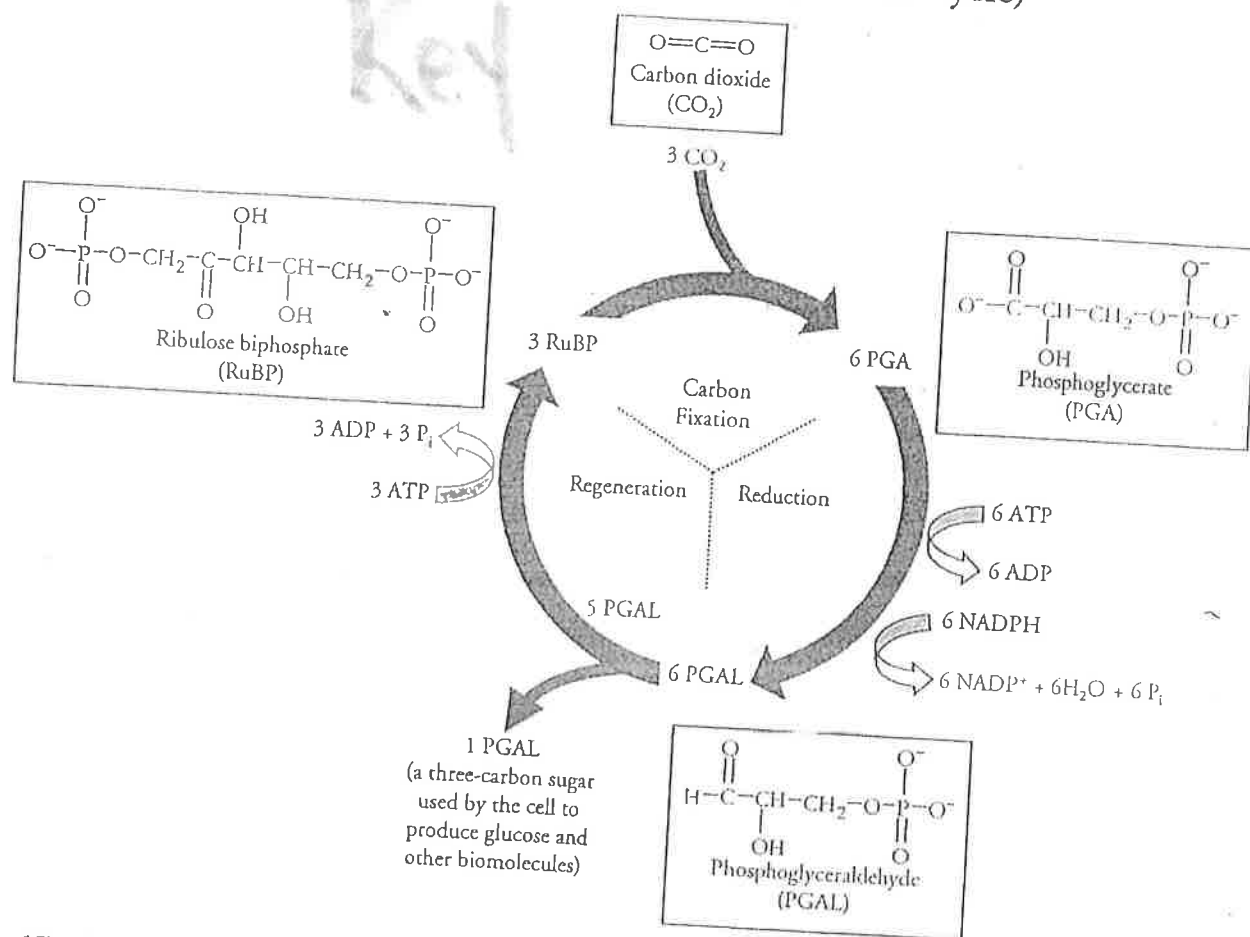


Model 3 – The Light-Independent Reactions (Calvin Cycle)



17. According to Model 3, what are the three phases of the Calvin cycle?
Carbon fixation, reduction, and regeneration.

Read This!

Model 3 is a simplified version of the Calvin cycle. Each of the three phases in the cycle consist of multiple reactions that are catalyzed by enzymes specific to that reaction. These enzymes have names like RuBisCo, phosphoglycerate kinase, and PGAL hydrogenase.

22. Refer to the reduction phase of the Calvin cycle in Model 3.
- What molecule does the PGA molecule turn into during this phase of the Calvin cycle?
The PGA molecule turns into PGAL.
 - Describe specifically how the structures of the two molecules in part a are different.
The PGA molecule loses an oxygen atom as it turns into PGAL.
 - Identify the types and numbers of molecules that provide the free energy necessary for the reduction of the PGA molecules.
Six ATP and six NADPH are used in the reduction phase as a source of energy.

25. The reaction in Model 1 shows glucose ($C_6H_{12}O_6$) as a product of photosynthesis.

- a. How many PGAL molecules will it take to make one molecule of glucose? Justify your answer with a discussion of numbers of carbon atoms.

Two PGAL molecules will be needed. Each PGAL molecule contains three carbon atoms, but a glucose molecule contains six carbon atoms.

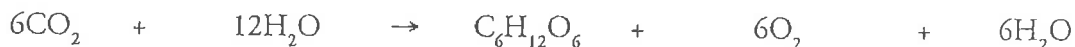
26. Where do the ADP and $NADP^+$ go after they are used in the Calvin cycle?

They travel back to the thylakoid to be recycled in the light-dependent reaction.

27. Explain in detail, using complete sentences, how the two reactions (light-dependent and light-independent) depend on each other.

Students should be able to articulate that the 18 ATP molecules and the 12 NADPH molecules produced during the light-dependent cycle are needed to power the light-independent cycle, and that the 18 ADP molecules and 12 $NADP^+$ molecules from the light-independent cycle are returned to the light-dependent cycle.

28. Under each molecule in the equation below, indicate whether it is involved (either used or produced) in the light-dependent reactions or the Calvin cycle.



Used in the Calvin cycle Used in the light-dependent reaction Produced in the Calvin cycle Produced in the light-dependent reaction Produced in the Calvin cycle

29. Throughout photosynthesis, energy is transferred from light to several molecules with increasingly higher potential energy. Use the words below to summarize the order in which the energy flow occurs.

electrons ATP glucose sunlight

sunlight \longrightarrow electrons \longrightarrow ATP \longrightarrow glucose

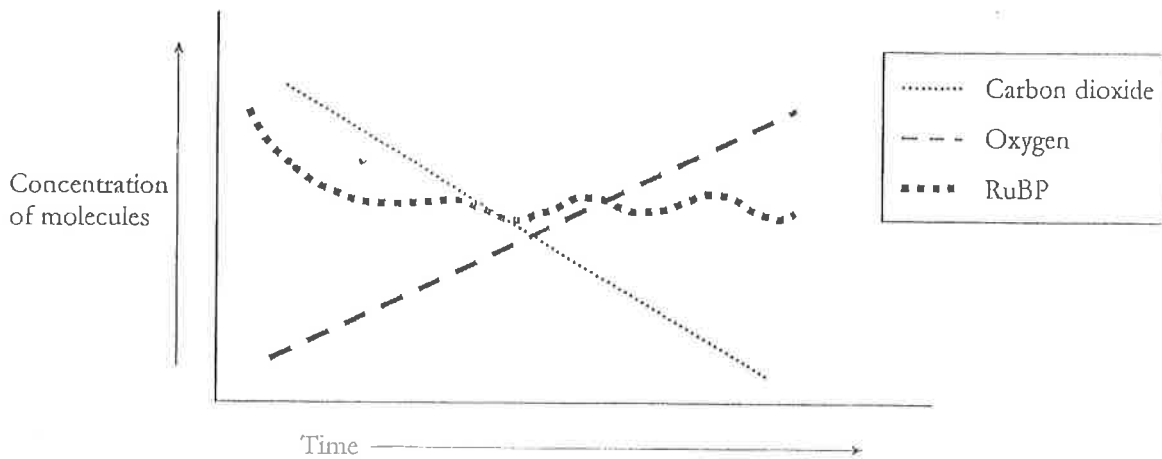
30. Although photosynthesis does produce some ATP, these molecules are not used to do the work of the plant cells. What other process occurs in the cells that provides the ATP necessary to do cellular work such as make proteins, divide cells, and move substances across membranes?

Cellular respiration uses the glucose that was made in photosynthesis.



Extension Questions

Model 4 – The Study of Photosynthesis



31. When algae are undergoing photosynthesis, the concentrations of various molecules change within the cells. These concentrations can be monitored and graphed. In complete sentences, explain the shape of each line on the graph in Model 4.

carbon dioxide—*The concentration of CO_2 starts high because it is a reactant in photosynthesis. As it is used, the concentration steadily decreases.*

oxygen—*The concentration of O_2 starts low because it is a product of photosynthesis and has not been produced yet. As it is produced, the concentration steadily increases.*

RuBP—*RuBP is constantly recycled during the Calvin cycle, so after an initial fall (from a resting state of no Calvin cycle activity), the RuBP concentration will remain fairly constant.*