Photosynthesis and the Environment

- enzymes catalyze the chemical reactions in the Calvin cycle, therefore we can look at factors that affect the rate of these reactions to understand how the rate of photosynthesis can be affected.

**Light Intensity and the Rate of Photosynthesis**
- when irradiance (light intensity per unit area of leaf) is low the rate of net CO₂ uptake is a negative value (there is a net amount of CO₂ given off by the plant).
- in the dark, CO₂ production is a result of cellular respiration.
- as irradiance increases the rate of photosynthesis increases until the uptake of CO₂ equals CO₂ released by cellular respiration.
- this point is called light-compensation point, where the net uptake of CO₂ is zero.
- beyond this point the rate of photosynthesis continues to increase.
- this is said to be light limiting, as light is required for these reactions.
- the light-saturation point is reached when the enzymes are saturated; they are unable to bind to a substrate, since there is more substrates than available active sites.
- the rate of photosynthesis reaches a plateau called CO₂ limited range since at this point reactions are determined by carbon fixation.
- see Fig. 2 on pg. 173

**Temperature and Rate of Photosynthesis**
- the light reactions do not depend on temperature as they occur in the thylakoid membrane.
- the reactions in the Calvin cycle are affected by temperature, since these reactions involve the use of enzymes.
- between 10 and 30°C the rate of photosynthesis increases with temperature, but at 40°C the enzymes become denatured so the rate of photosynthesis levels off.
- see Fig. 4 on pg. 174

**Oxygen Concentration and the Rate of Photosynthesis**
- oxygen has an inhibitory effect on photosynthesis.
- the rate of photosynthesis decreases as oxygen concentrations increase.
- oxygen competes with carbon dioxide for the active sites on rubisco (the enzyme used to fix carbon onto RuBP)
- when CO₂ binds, carbohydrates are produced.
- when O₂ binds, photorespiration occurs and the rate of photosynthesis is reduced.
- see Fig. 6 on pg. 175

**Photosynthetic Efficiency**
- is the net amount of carbon dioxide uptake per unit of light energy absorbed.
- is also known as quantum yield.
- C₄ plants will take in the same amount of CO₂ per unit of light energy as temperature increases.
- $C_3$ plants decrease in their quantum yield as temperatures increase.
- see Fig. 7 on pg. 175
- during the hot summers, $C_4$ plants like Crabgrass out compete $C_3$ plants like Kentucky bluegrass.

**Sun Plants Versus Shade Plants**
- Shade plants have leaves that are thinner, broader and greener (contain more chlorophyll).
- they are more efficient at harvesting light at low intensities.
- Sun plants have a high light-saturation point and maximum rate of photosynthesis.
- Shade plants have lower light compensation points because they lower respiration rates in order to adapt to limited light conditions.
- see Fig. 10 on pg. 177.

**Seatwork**
Pg. 178 #1 - 9