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 CO_2 uptake is a negative value (there is a net amount of CO_2 given off by the plant).
- in the dark, CO_2 production is a result of cellular respiration.
- as irradiance increases the rate of photosynthesis increases until the uptake of CO_2 equals CO_2 released by cellular respiration.
- this point is called **light-compensation point**, where the net uptake of CO_2 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 CO_2 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 a 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 CO_2 binds, carbohydrates are produced.
- when O_2 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**.
- C_4 plants will take in the same amount of CO_2 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

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