DISSOLVED OXYGEN & PHOTOSYNTHESIS

Exploring Water Quality

Factors Influencing Water Quality

- Dissolved oxygen
- Temperature
- Turbidity
- Phosphates
- Nitrates
- pH

Temperature & Water Quality

- Aquatic plants can alter the concentration of dissolved oxygen
  - *Photosynthesis*

$$6CO_2 + 6H_2O \xrightarrow{\text{(energy from the Sun)}} C_6H_{12}O_6 + 6O_2$$

- Water temperature can change the concentration of dissolved oxygen
  - *Water at lower temperatures – higher concentration of DO*
  - *Water at higher temperatures – lower concentration of DO*
- Water temperature can change sensitivities of organisms to toxins, parasites, and pathogens

Dissolved Oxygen & Water Quality

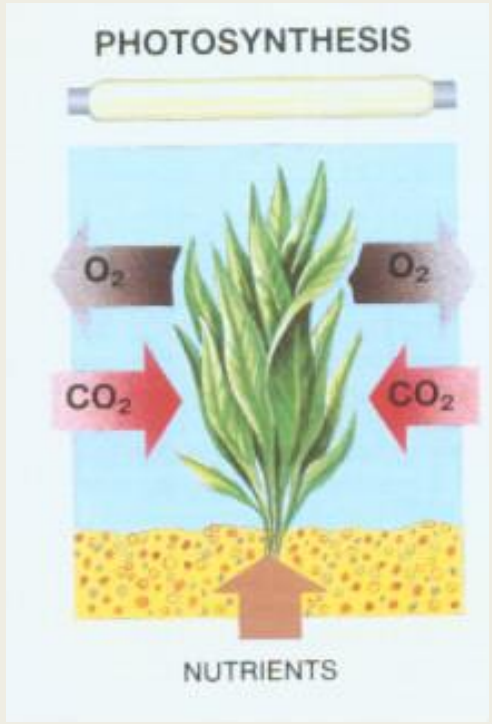
- Most heterotrophs require oxygen for cellular respiration
  - *Fish*
  - *Crayfish*
  - *Aquatic insects [larva]*

Heterotrophs – Require oxygen for cellular respiration: the process that generates energy through the catabolism of simple sugars (glucose)

- Greater concentration of DO
  - *Potential to support greater numbers of aerobic aquatic heterotrophs*
- Lower concentration of DO
  - *Lower numbers of aerobic aquatic heterotrophs can be supported*

Dissolved Oxygen & Water Quality

- Sources of dissolved oxygen:
  - *Atmospheric oxygen can dissolve in water [waterfalls, rapids, etc.]*
  - *Photosynthesis produces oxygen as a byproduct of the Light Reactions*
- Factors decreasing dissolved oxygen:
  - *Organic waste*
    - Increases microbial life requiring oxygen to generate cellular energy [respiration] to support life functions
    - Microbes includes bacterial organisms



http://www.aquariumlife.net/articles/aquatic-plants/photosynthesis-respiration-aquatic-plants/152.asp

http://naturalaquariums.com/plantedtank/0702.html

Photosynthesis:

-Like terrestrial plants, aquatic plants take in H_2O and CO_2 to make simple sugars through photosynthesis

-Photosynthesis converts light energy into chemical energy to support life functions within the organism

-Use the chemical energy from photosynthesis to make one molecule of the simple sugar glucose

$$6CO_2 + 6H_2O \xrightarrow{\text{Light Energy}} C_6H_{12}O_6 + 6O_2$$

Photosynthesis

- Plants take in light energy and convert it into chemical energy during the light dependent reactions
  - *Give off oxygen as a waste product from the Light Dependent Reactions*
- The products of the light reactions [ATP and NADPH] power the light independent reactions to manufacture glucose [a simple sugar – $C_6H_{12}O_6$]
- Glucose serves as the basis for manufacturing lipids, amino acids [sequenced into proteins], and complex carbohydrates]
  - *The building blocks for plant tissues*

Plants Release Oxygen

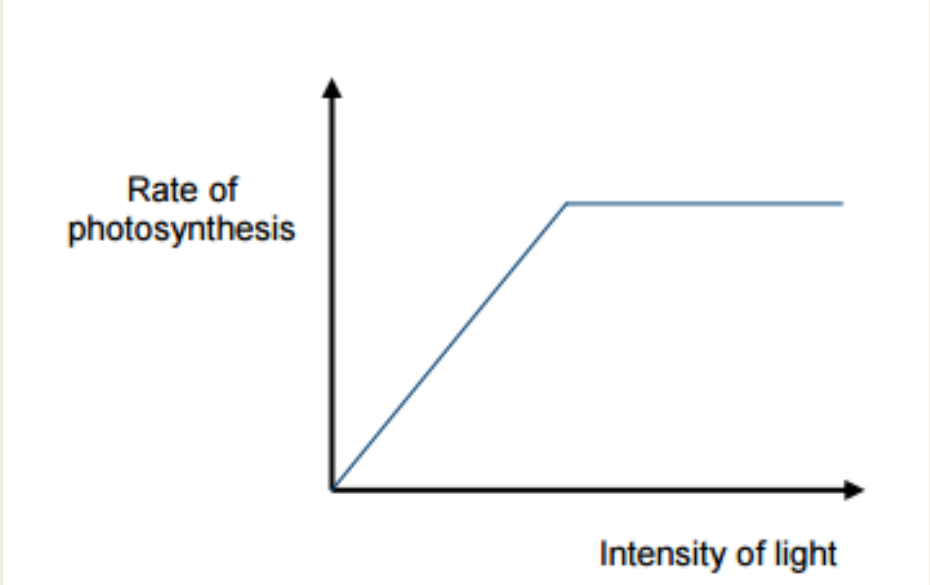
- During the Light Dependent reactions:
  - *H_2O is broken down into hydrogen and oxygen*
  - *Oxygen is released as a byproduct*
- Plants also require oxygen
  - *Release more O_2 than required for cellular respiration*

Impact of Organic Waste on DO

- Organic waste:
  - *Sewage*
  - *Farm runoff*
  - *Discharge from food processing plants*
- Impact:
  - *Decomposers [microbes] use O_2 for cellular respiration*
  - *Explosion of microbial life increasing O_2 uptake*
  - *The action of microbes results in oxygen poor water which may be unable to support life*

Light Intensity & Photosynthesis

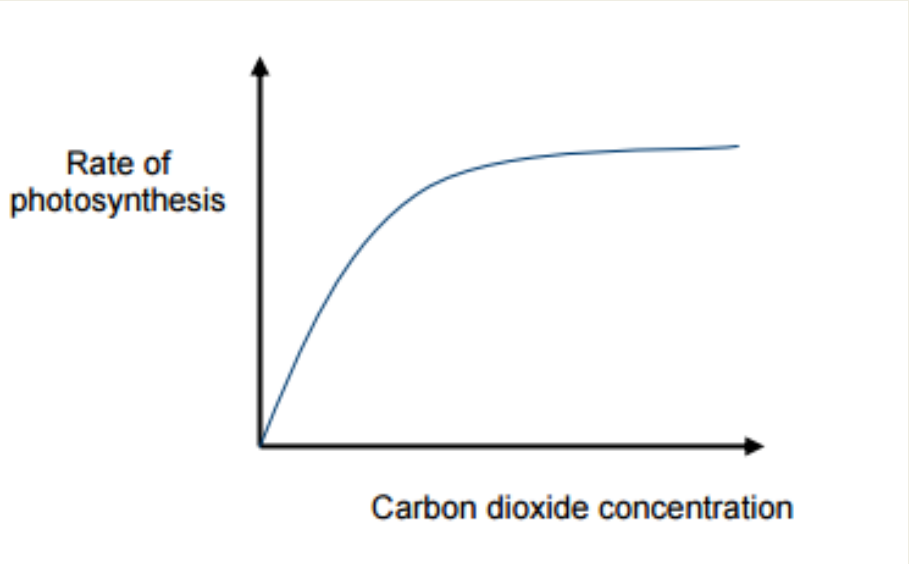
- As light intensity increases, the rate of photosynthesis increases
- Note that the rate of photosynthesis does level off



RSC – Advancing the Chemical Sciences

Concentration of CO_2 & Photosynthesis

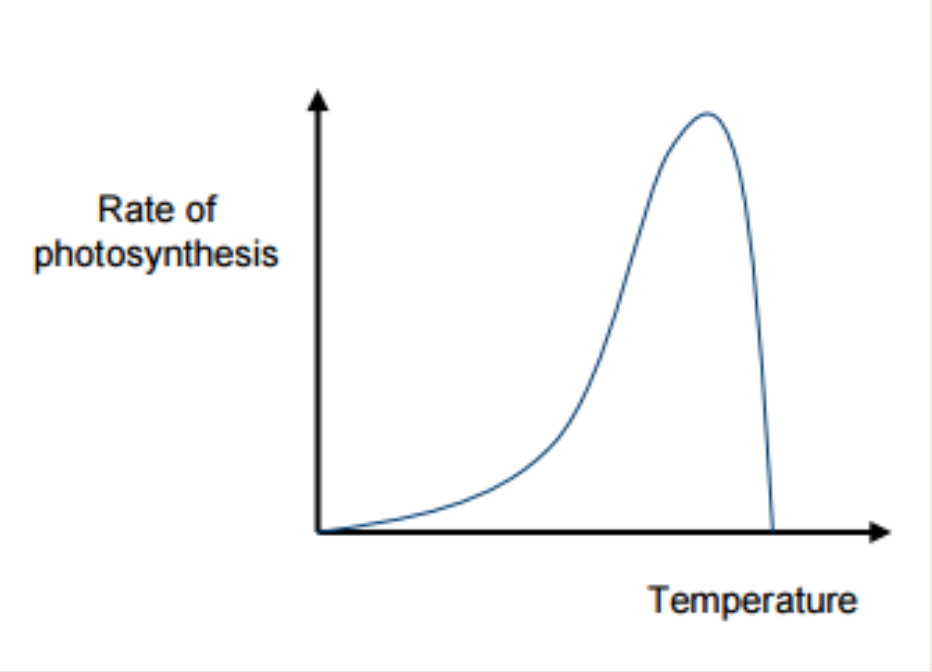
- The rate of photosynthesis increases with greater concentrations of CO_2
- Increasing the concentration of CO_2 will increase the rate of photosynthesis by providing additional raw materials
- The rate levels off – there is a limit



RSC – Advancing the Chemical Sciences

Temperature & Photosynthesis

- The rate of photosynthesis will increase with increasing temperature
- Enzymes have optimum temperatures
  - *Determines the point at which the rate drops*
  - *Enzymes are proteins and are degraded at high temperatures*



RSC – Advancing the Chemical Sciences

Turbidity & Water Quality

- Turbidity is:
  - *An optical property of water*
  - *Dependent upon the amount of light reflected by suspended particles within the water*
  - *Used as a measure of the volume or quantity of matter present in a body of water*
  - *Reduces the depth to which sunlight can penetrate*
    - Acts as a limiting factor for photosynthesis

What Influences Turbidity?

- Erosion – increases the amount of sediment suspended in water
- Suspended particles – silt, clay, plankton, industrial wastes, sewage, etc.
- Increased water temperature – cloudy water absorbs more light energy and results in higher temperature of water
- An increase in water temperature reduces the solubility of oxygen and, therefore, reduces the concentration of dissolved oxygen in water

Turbidity & Water Quality - 2

- What problems are associated with turbid water?
  - *Light cannot penetrate the water as efficiently*
  - *Aquatic plants are exposed to limited light*
- Dissolved oxygen concentration may be reduced
  - *This may affect animal populations*
  - *Turbid water holds less dissolved oxygen*