Nashua River Watershed Investigations for Grades K- 8
Lesson # 6-2

Title: 6-2 Photosynthesis and Floating Plants

Grade Level & Standard: Grade 6
6MS-LS1-2. Develop and use a model to describe the ways parts of cells contribute to key cellular functions of obtaining nutrients and water from its environment, disposing of waste, and producing energy: a. the nucleus contains genetic information (DNA) which regulates a cell's activities; b. chloroplasts are the site of photosynthesis which produces necessary glucose and oxygen; c. mitochondria facilitate cellular respiration (energy production); d. vacuoles store materials, including water, nutrients and waste; e. the cell membrane is a protective barrier that enables nutrients to enter the cell and wastes to be expelled; f. the cell wall provides structural support to some types of cells.

Objective: Students will observe a water lily leaf and stem and create ideas about how the structures contribute to successful photosynthesis. Students will calculate surface area of a water lily leaf available for photosynthesis and compare it to a tree leaf.

Vocabulary:

- All organisms, animals and plants, must obtain energy to maintain basic biological functions for survival and reproduction. Plants convert energy from sunlight into sugar in a process called **photosynthesis**. Photosynthesis uses energy from light to convert water and carbon dioxide molecules into glucose (sugar molecule) and oxygen. The oxygen is released from leaves while the energy contained within glucose molecules is used throughout the plant for growth, flower formation, and fruit development.

  Carbon Dioxide & Water & Light Energy = Glucose & Oxygen

- **Respiration** occurs when glucose (sugar produced during photosynthesis) combines with oxygen to produce usable cellular energy. This energy is used to fuel growth and all of the normal cellular functions. Carbon dioxide and water are formed as by-products of respiration.

  Glucose & Oxygen = Water & Energy & Carbon Dioxide

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Background:

Floating Plants - At the water surface there often is unobstructed full sun. Water lilies have a large surface area of leaf to maximize sunlight capture and gas exchange. On most floating leaves, the stomata are on the top surface of a leaf. They do use organic nutrients from the bottom of rivers or ponds. Also, the floating leaves are firm or leathery but flexible enough to resist tearing by wave action. Floating leaves often have well-developed air chambers (lacunae), which provide buoyancy, and they may also have hard cells (sclereids) within the mesophyll that provide some toughness for the leaf and prevent the layers from becoming collapsed.

- Examples of floating plants that are attached to bottom:
    - water lily (*Nymphaea odorata*)
    - yellow pond-lily (certain species of *Nuphar*)
    - water-shield (*Brasenia schreberi*)
    - water-chestnut (*Trapa natans)*

- Examples of floating plants with no attachment to the mud or bottom and with inflated portions of leaves or stems or special hairs that enable the plant to remain floating:
    - water-hyacinth (*Eichhornia crassipes*) with inflated petioles
    - duckweeds (Subfamily Lemnoideae of Family Araceae, *Lemna, Spirodela, Wolffia, Wolffiella*), among the tiniest vascular plants
    - bladderworts (*Utricularia*) with a modified, submersed stem system for photosynthesis and catching invertebrate prey and, sometimes, a rosette of inflated stems floating at the surface of the water (*U. inflata*)
    - mosquito fern (*Azolla filiculoides, A. mexicana*)

A number of floating aquatic species are excellent organisms in which to study population growth. Under full sun and non-limiting nutrients, a single individual can be introduced into a pond and multiply rapidly via vegetative means. For example, duckweeds (subfamily Lemnoideae of family Araceae) clone by forming plantlets on the mother plant, doubling in surface coverage approximately every two days. This makes them an excellent classroom plant. Water-hyacinth, *Eichhornia crassipes*, and floating fern species of *Salvinia* and *Azolla* also show explosive population growth. In the tropics and heated quiet waters of ponds and lakes, such species can completely cover the water surface within several months, and for that reason are considered pernicious aquatic weeds, which are removed at great expense and trouble because they clog channels and choke out other forms of life in the body of water.

Discussion points: How do floating aquatic plant structures contribute to photosynthesis? How can a leaf exchange gases when it is floating on water?

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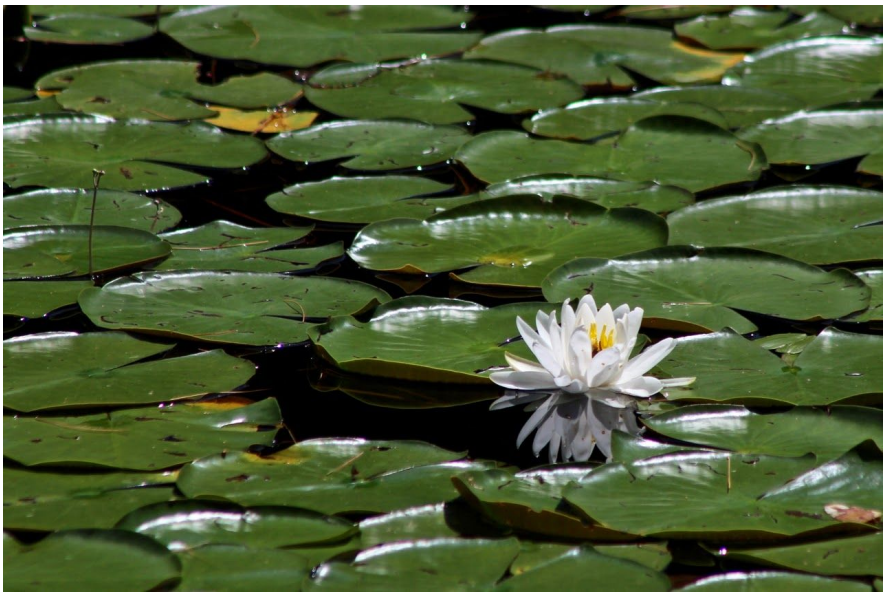

Scented Pond Lilies maximize sunlight for photosynthesis
Photo taken by Kimberly King

Materials:

- 5 white basins
- Hand lenses and/or other magnifying tools
- Measuring tapes or rulers
- Collect water lilies and other floating aquatic plants you can find in a mature river or pond. These must be collected April to October. Plants can be kept for a short time in an aquarium or you can press the plants using newspaper and books.
- Floating aquatic plants can be ordered from Carolina Biological Supply or other supply companies. Duckweed is a good example of logarithmic growth and reproduces well in a science room.
- Tree branch with roundish leaves.

Procedure:

1. Set up basins with floating plants in water.
2. Observe the leaf closely. Look for the waxy cuticle. Look at the top and the bottom of the leaf under magnification. Look for air pockets underneath the leaf and stomata (need high magnification) on top of the leaf.
3. What do you notice about the stem? How does it compare to a land plant?
4. Calculate the surface area the water lily has available to absorb sunlight and exchange gases. Compare leaf area to a leaf from a tree.

Data sheet: (attached)

- Floating Leaves and Photosynthesis data sheet (2 pages)

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Floating Leaves and Photosynthesis Data Sheet **NRWI Lesson 6-2**

Name_____

1. Observe a floating water lily in a basin. Why is it floating?

2. Observe the leaf closely. Look for the waxy cuticle. Look at the top and the bottom of the leaf under magnification. Look for air pockets underneath the leaf and stomata on top of the leaf.

3. What do you notice about the stem?

4. Look at the stem of the tree branch. Compare the two plants. How do they differ?

Plant part	Describe	Draw
Lily leaf		
Lily stem		

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Trace the shape of water lily pad & one other plant leaf below.
(or on another sheet)

1) Calculate surface area of both leaves using the formula to find the area of a circle.
Area of a circle = πr^2

2) Area of lily leaf _____Area of tree leaf_____

3) All plants need to exchange gases with the environment (CO2 and O2). How would a large surface area contribute to gas exchange?

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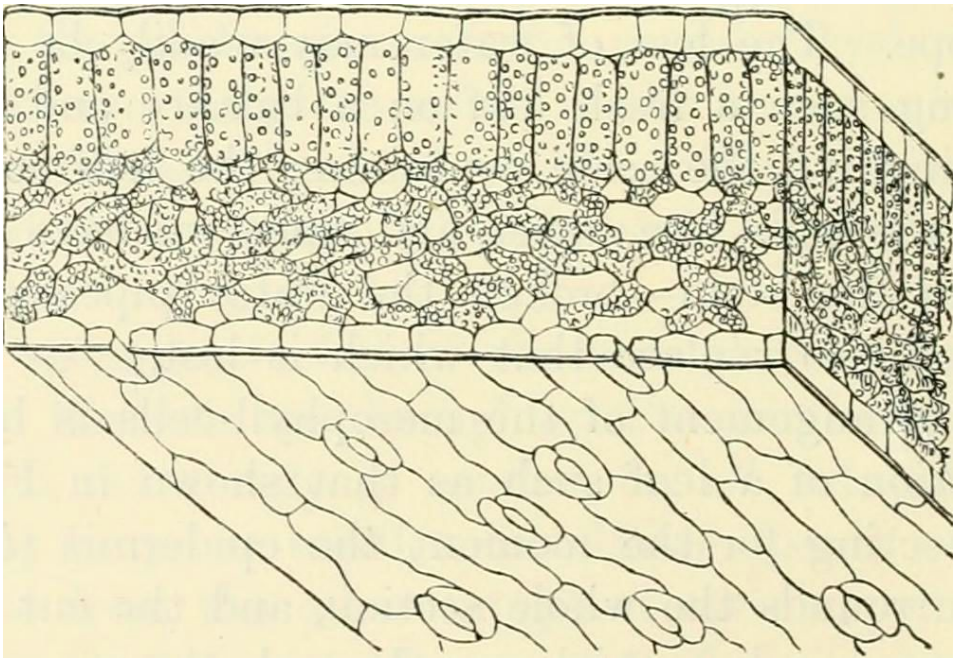
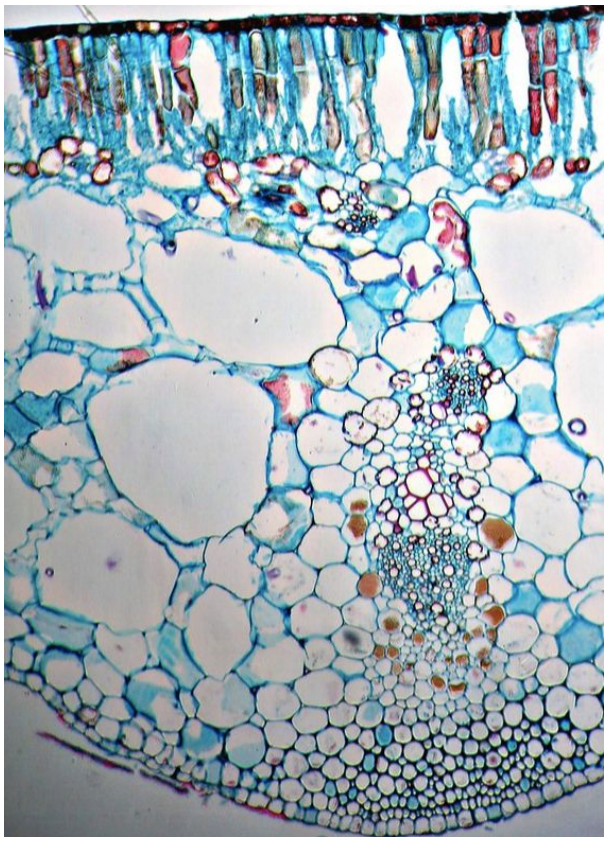
Transverse section of a White Birch Leaf (*Betula alba)*



"Trees; a handbook of forest botany for the woodlands and the laboratory (1904)"

Transverse section of water lily leaf (Nymphaea)



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