

# Chapter 5



*Plant Processes*

# Photosynthesis and Respiration

- ❖ **Movement of materials in plants** - plants make their own foods using the raw materials water, carbon dioxide (CO<sub>2</sub>), and inorganic chemicals in the soil.
- ❖ Just like humans and animals, **plants produce waste.**

Most of water in plants enters through the **roots**.

- ❖ Water moves into root cells and then up the plant to where it is used. **PLANTER TIP** - When you move or transplant a plant, water is needed to compensate for the damaged roots.
- ❖ **Leaves** are where most gas exchange occurs in plants. The leaves function as the lungs of the plant. Most of the plants water exits the plants through the leaves. Carbon dioxide (CO<sub>2</sub>), oxygen, and water vapor exit and enter the plant through the leaf.

# Leaf structure and function

- ❖ A leaf is composed of several layers.
- ❖ Epidermis - the outer cell layer of a leaf, thin nearly transparent, sunlight is able to penetrate to the inside of the leaf so photosynthesis can occur.
- ❖ Waxy cuticle - helps keep the leaf from drying out and covers the epidermis
- ❖ Stomata - are the small openings in a leaf. They act as doorways for raw materials such as carbon dioxide (CO<sub>2</sub>), water vapor and water gases to enter and exit the leaf. These are also found in stem of plant.
- ❖ Two guard cells surround each stoma and control the stomata's size.

## Guard cells size change

- ❖ As water moves into the guard cells, they swell and bend apart, causing the stoma to open. As the guard cells lose water, they deflate causing the stoma to close.
- ❖ Stomata usually open during the day, that's when most plants need to take in raw materials in order to make food. On a hot sunny day an outdoor plant can lose up to 1 liter of water per day.
- ❖ Stomata usually close at night. In most plants the food making process slows down after sundown.
- ❖ No matter what time of day stomata can close if a plant is losing too much water.

## Two layers inside a leaf

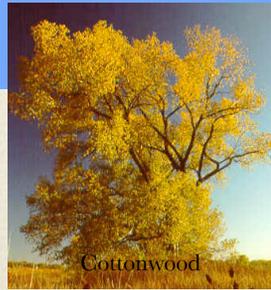
- ❖ Spongy layer - water and carbon dioxide (CO<sub>2</sub>) fill this layer
- ❖ Palisade layer - where most of the food is made in the plant (where photosynthesis takes place)

# explanation of photosynthesis



Water consumption and photosynthesis rates vary from plant to plant species.

❖ EXAMPLE - Cottonwood trees, Bradford pear trees grow rapidly while sugar maple trees, and white oak trees are very slow growers.



Cottonwood



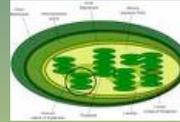
Bradford pear



White oak

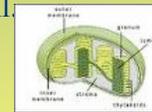
# Chloroplast and Plant Pigments

❖ A leaf cell contains green structures called **chloroplast**.



❖ Why are chloroplast **green**?

❖ Chloroplast appear green because they contain a green pigment called **chlorophyll**. When you look at a leaf, you are seeing green light energy reflected from chlorophyll. Most of the other colors of the spectrum, especially blue and red, are absorbed by the chlorophyll.



## Plant Pigments (cont'd)

- ❖ In the spring and summer, most leaves have so much chlorophyll that it hides all other pigments.
- ❖ In the fall, the chlorophyll in some leaves breaks down and the leaves change color as other pigments become visible. Pigments are important to plants because the light energy that they absorb is used to make food. In plants, this food making process - photosynthesis - takes place in the chloroplast.

## Plant pigments other than chlorophyll



- ❖ anthocyanins - red pigments - give these pansies their purple color
- ❖ carotenoids - yellow pigments

## Why do leaves change color in the fall?

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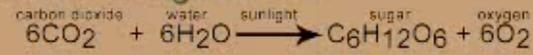
- ❖ Leaves change color in the fall because of the declining temperatures and short days. These conditions lead to a breakdown of **chlorophyll**, which allow **other pigments** to become visible.

## How do plants make food?

- ❖ Photosynthesis is the process in which a plant's chlorophyll traps light energy and sugars are produced.
- ❖ Photosynthesis will only occur in plant cells that contain chloroplast.

# Photosynthesis Song

Photosynthesis  
Song  
by  
Peter Weatherall  
[www.kidsinglish.com](http://www.kidsinglish.com)



## The equation for photosynthesis



## video clip - photosynthesis

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❖ [http://video.google.com/videoplay?  
docid=-8137271476024676334#docid=-737778  
8683046188633](http://video.google.com/videoplay?docid=-8137271476024676334#docid=-7377788683046188633)

There are 2 sets of reactions that take place during photosynthesis

- ❖ light dependent reactions
- ❖ light independent reactions (also known as dark reactions)

## Light dependent reactions

- ❖ Some of the chemical reactions that take place during photosynthesis need light but others do not. The reactions that require light in plants are called **light dependent reactions**.
- ❖ During light dependent reactions , chlorophyll and other pigments trap light energy that eventually will be stored in sugar molecules. Light energy causes water molecules to split into oxygen and hydrogen
- ❖ The oxygen from the water leaves the plant through the stomata. This is the oxygen we breathe. The hydrogen that is left is saved and used by the plant in photosynthetic reactions that take place when there is no light.

## Light independent reactions (dark reactions)

- ❖ There are reactions that take place during photosynthesis that DO NOT require light. CO<sub>2</sub> is used in those reactions. The light energy trapped during the light reactions is used to combine carbon dioxide and hydrogen to make sugars.
- ❖ Glucose is one of the important sugars made during photosynthesis. The chemical bonds that hold the glucose and other sugars together are stored energy.
- ❖ Excess sugar is stored in the plant as a different form of sugar and/or starch.

# Cellulose

- ❖ an important part of the plant cell wall
- ❖ made from glucose
- ❖ leaves, roots and stems of a plant are made of cellulose

# Importance of Photosynthesis

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- ❖ 1. This reaction produces food for plants
- ❖ 2. Photosynthetic organisms use carbon dioxide and release oxygen
- ❖ 3. Photosynthesis removes carbon dioxide from the atmosphere and adds oxygen to it. This helps prevent global warming.
- ❖ 4. Approximately 90% of the atmospheres oxygen is a result of photosynthesis.

We live in what is considered the central portion of the United States. In this part of the country, weed killers don't work very well in July/August. Why???

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- ❖ Stomata must be open in order for a weed killer to enter the plant and poison it. July/August are very warm, thus the stomata are closed most of the daytime hours.
- ❖ One would want to put weed killer (such as RoundUp) on weeds in the early morning hours, (when there is still dew on the ground) while the stomata are still open in order for the poison to enter the plant.

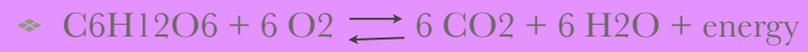
# How is food broken down?

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- ❖ **Respiration** - a series of chemical reactions that breaks down food molecules and releases energy. Respiration occurs in cells of most organisms.
- ❖ **Aerobic respiration** - respiration that uses oxygen to break down food chemically. In plants and many other multicellular eukaryotic organisms the aerobic respiration takes place in the mitochondria.

## Formula for aerobic respiration

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- ❖ Before aerobic takes place the large glucose molecules must be broken down. This happens in the cytoplasm of the cell. The waste products from aerobic respiration are carbon dioxide and water. Energy is also released. Every cell in a multicellular organism requires this energy.
  - ❖ Respiration changes food energy into a form all cells can use. This energy is responsible for all of the life processes on Earth.
  - ❖ Plants use the energy produced from respiration to transport sugars and open and close stomatas. Plants also use this energy to produce chlorophyll. Aerobic respiration also returns carbon dioxide to the atmosphere, where it can be used again by plants and some other organisms for photosynthesis.

❖ Aerobic respiration is almost the reverse of photosynthesis. Because all plant cells contain mitochondria, all plant cells and any cell with mitochondria can go through the process of respiration. Photosynthesis will only take place in plant cells that contain chloroplast. Not all plant cells contain chloroplast.

# Comparing Photosynthesis to Respiration

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**Table 1 Comparing Photosynthesis and Aerobic Respiration**

	<b>Energy</b>	<b>Raw Materials</b>	<b>End Products</b>	<b>Where</b>
<b>Photosynthesis</b>	stored	water and carbon dioxide	glucose and oxygen	cells with chlorophyll
<b>Aerobic Respiration</b>	released	glucose and oxygen	water and carbon dioxide	cells with mitochondria

Aerobic respiration is almost the reverse of photosynthesis. Because all plant cells contain mitochondria, all plant cells and any cell with mitochondria can go through the process of respiration. Photosynthesis will only take place in plant cells that contain chloroplast. Not all plant cells contain chloroplast.

# Plant Responses

- ❖ All living things respond to stimuli. Stimulus may external (light) or internal (hormones).
- ❖ Internal stimuli are usually chemicals produced by an organism. Often times the chemicals an organism produces are **hormones**.

# Hormones

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- ❖ Substances made in one part of an organism for use somewhere else in the organism.

# Plant Hormones

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- ❖ Control changes in growth of the plant that result from tropism and affect plant growth. Hormones work in very minute amounts. (parts/million)

# Ethylene

- ❖ a plant hormone that causes a layer of cells to form between leaves and stem. Ethylene is one reason a plant loses its leaves. Ripened plants produce ethylene and release ethylene gas, so one plant and the gas it releases can affect a neighboring plant.
- ❖ Fruit farmers often pick their fruit when it is green. They then expose the green fruit to ethylene gas in order to ripen it. The fruit doesn't stop ripening and rots.
- ❖ Proof that one bad apple can spoil the whole bunch - this is due to ethylene gas formation - causing ripening and rot. Ethylene gas also causes drop.

# Auxin

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- ❖ a plant hormone that regulates responses to light (phototropism) and gravity.
- ❖ Auxin cause stem apex to lean towards the light. It is responsible for root growth and stem elongation. Auxin stimulates cell growth - cells get bigger. Auxin can also control the production of the plant hormones ethylene and cytokinins.
- ❖ Manmade auxins are used in orchards to spray on fruit so trees will flower and bear fruit at the same time. It will prevent fruit from dropping. Commercial fruit growers want to harvest their trees all at the same time. High doses of auxins are also used as weed killers.
- ❖ If you are in the fruit business, you do not want trees to drop the fruit because of bruising.

# Gibberellins

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- ❖ plant hormones that are responsible for stem elongation and enhancing fruit development. It causes cell division and elongation. Causes bolting. (stimulates flowering)

# Cytokinins

- ❖ a plant hormone that stimulates the growth of lateral branches, causing a plant to be bushy rather than long and stringy.
- ❖ Cytokinins can be sprayed on stored vegetables to keep them fresh longer.

## ABA (Abscisic Acid)

- ❖ plant hormone that causes buds to remain dormant for the winter. ABA stops working in the spring and buds will again sprout.
- ❖ It is responsible for the opening and closing of the stomata.

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❖ Ethylene and ABA are hormones that are growth inhibitors, while auxin, gibberellins, and cytokinins are growth promoter hormones. Many hormones act in combination with each other. This makes determining how they operate very difficult. Sometimes one hormone triggers the effect of another hormone.

# Tropism

- ❖ movement caused by a change in the growth and can be positive or negative. Plants may grow towards something (positive tropism) or away from something (negative tropism).
- ❖ touch tropism - (thigmotropism) When a pea plant touches a solid object, it responds by growing faster on one side of its stem than on the other side.
- ❖ light tropism - (phototropism) When a plant responds to light, the cells on the side of the plant opposite the light get longer than the cells facing the light. Because of this uneven cell growth the plant bends toward the light.
- ❖ gravity tropism - (gravitropism) When the roots of a plant grow downward into the soil due to gravity. This is a positive response to gravity. (grows in the same direction gravity is forcing on it). The stem growing upward is an example of a negative response to gravity. (grows in the opposite direction gravity is forcing on it)

# Photoperiods

- ❖ A plants response to the number of hours of daylight and darkness it receives daily. The changes in the length of daylight and darkness affect plant growth.

## Long day plants

- ❖ Plants that require less than 10 - 12 hours of darkness to flower. EX: sunflowers, iris

## Short day plants

- ❖ Plants that require 12 hours or more of darkness to flower.
- ❖ When a short day plant receives less darkness than it needs - it's leaves become larger instead of it flowering. EX - poinsettias, strawberries, ragweed

## Day-Neutral Plants

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- ❖ Day-neutral plants are plants that do not require a specific photoperiod and can begin the flowering process over a range of night length.

# Carolus Linnaeus

- ❖ developed systemic approach for classifying floral structures as a way to classify a flowering plants.
- ❖ The main basis that scientist use to classify flowering plants in by the floral structure.

## Careers involving plants

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- ❖ horticultural, botany, conservation, landscape design, agriculture, plant engineering, genetics, etc.

## Chapter 5 Vocabulary

- ❖ auxin - plant hormone that causes plant leaves and stems to exhibit positive response to light
- ❖ anthocyanins - red pigment found in plants
- ❖ botany - scientific study of plants and plantlike organisms
- ❖ carotenoids - yellow, orange pigments found in plants
- ❖ cellulose - an important part of the cell wall in plants, made from glucose
- ❖ chlorophyll - green, light trapping pigment in plant chloroplast
- ❖ chloroplast - green, chlorophyll containing, plant cell organelle that converts sunlight, carbon dioxide, and water into sugar.

- ✦ cytokinins - plant hormone that stimulates the growth of lateral branches causing the plant to grow “bushy” when the plant stem is cut. These hormones strongly promote plant growth and development. Promote cellular division.
- ✦ day neutral plants - plant that doesn't require a specific photoperiod and can begin the flowering process over a range of night lengths
- ✦ epidermis - outer cell layer of the leaf
- ✦ gibberellins - plant hormone that stimulates stem elongation and fruit development
- ✦ guard cells - specialized epidermal cells that control the opening and closing of the stomata. closed stomata = lose water    open stomata = swell with water

- ❖ hormones - substance made in one part of the plant for use in another part of the plant. Control the changes in growth that result from tropism and affect other plant growth. Very effective in very small amounts.
- ❖ light independent reaction - reactions that don't need light. Carbon dioxide and the raw materials from the air are used in these reactions.
- ❖ long day plants - plant that generally requires short nights - less than 10 hours to 12 hours of darkness - to begin the flowering process.
- ❖ photoperiodism - a plant's response to the lengths of darkness each day

- ◆ Respiration - series of chemical reactions used to release energy stored in food molecules
- ◆ short day plants - plant that generally requires long nights - 12 or more hours of darkness to begin the flowering process
- ◆ spongy layer - layer which holds the carbon dioxide and water vapor needed in the food making process.
- ◆ stomata - tiny openings in a plant's epidermis through which carbon dioxide and water vapor gases enter and exit a leaf.
- ◆ tropism - positive or negative plant response to an external stimulus such as touch, light, or gravity