

Module 2: How Plants Work Plant Growth and Development



IOWA STATE UNIVERSITY
University Extension

DEPARTMENT OF
HORTICULTURE

IOWA NURSERY &
LANDSCAPE
ASSOCIATION

Welcome to the Iowa Certified Nursery Professional Training program Module 2: How Plants Work: Plant Growth and Development.

Module Objectives

1. Be able to identify the components of photosynthesis, respiration, and transpiration.
2. Be able to order the processes of plant growth.
3. Know the general formulas for photosynthesis and respiration.
4. Understand how changing the environment effects plant growth

IOWA STATE UNIVERSITY
University Extension

DEPARTMENT OF
HORTICULTURE

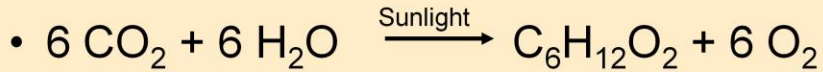
IOWA NURSERY &
LANDSCAPE
ASSOCIATION

Upon completion of this module, you will be able to fulfill each of the objectives listed below.

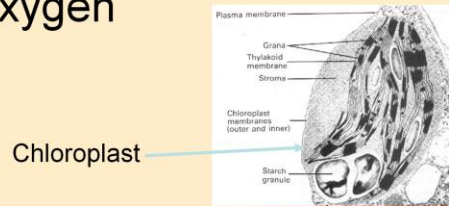
1. You will be able to identify the components of photosynthesis, respiration, and transpiration.
2. You will be able to order the processes of plant growth.
3. You will know the general formulas for photosynthesis and respiration.
4. You will understand how changing the environment effects plant growth and development.

Photosynthesis

- Plants make own food



- Carbon dioxide + water (in light) \longrightarrow carbohydrates + oxygen



IOWA STATE UNIVERSITY
University Extension

DEPARTMENT OF
HORTICULTURE

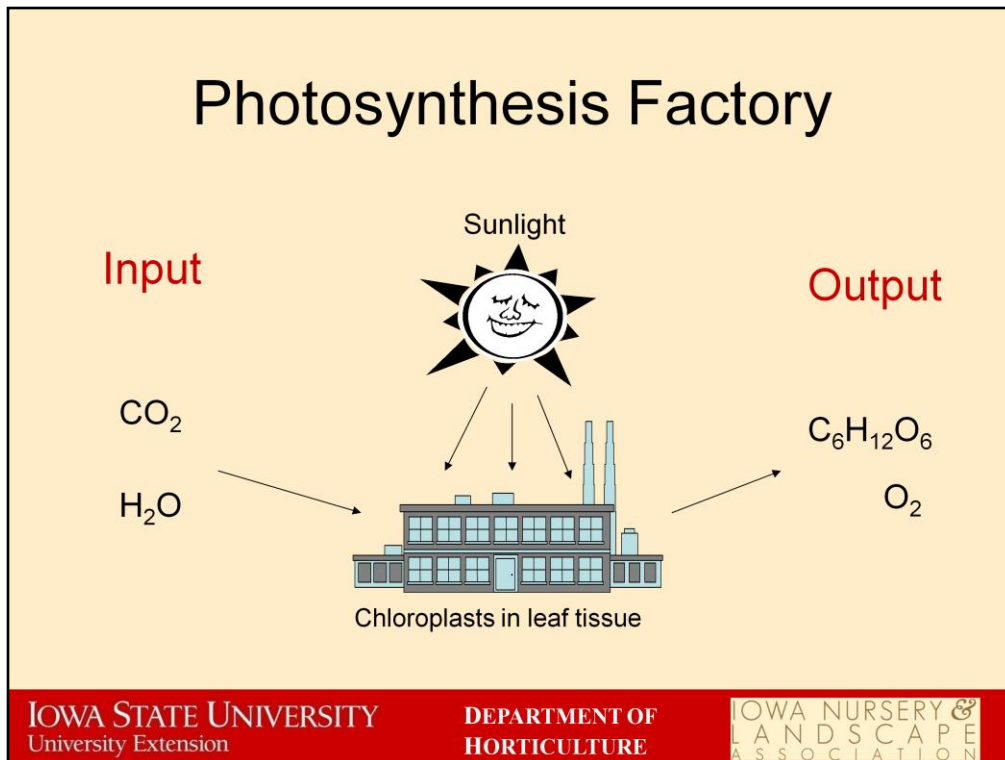
IOWA NURSERY &
LANDSCAPE
ASSOCIATION

Photosynthesis is the plant process that enables plants to produce their own food. Plants take carbon dioxide and water and processes them into carbohydrates and oxygen. This change is done in the chloroplasts. Chloroplasts are organelles that contain the green pigment, chlorophyll. Aside from making the leaves appear green, chlorophyll traps light energy for the plant to use when it changes the carbon dioxide and water into carbohydrates and oxygen.

The carbohydrates produces through photosynthesis can be used for any one of the following purposes:

1. Direct plant growth;
2. Synthesized into enzymes and chemicals used to control growth and development;
3. Stored for later use.

The oxygen produced is a by product that is lost through the stomata in the leaf surface.



Imagine the chloroplasts are little factories. The inputs are carbon dioxide and water. In the factory (chloroplast), the sun light energy powers the change of carbon dioxide and water into carbohydrates and oxygen. The outputs are carbohydrates and oxygen.

Photosynthesis only occurs during daylight when plants are exposed to the sun. Photosynthesis is like people eating lunch.

Respiration

- Process done by ALL living things
- Carbohydrates from photosynthesis into chemical energy
- $C_6H_{12}O_6 + 6 O_2 \longrightarrow 6 CO_2 + 6 H_2O + ATP$
- ATP is plant chemical energy

IOWA STATE UNIVERSITY
University Extension

DEPARTMENT OF
HORTICULTURE

IOWA NURSERY &
LANDSCAPE
ASSOCIATION

All living organisms respire. Respiration is the change of food energy into chemical energy used to produce enzymes and grow. In plants respiration happens all times of day and it not dependent on sunlight. The plant takes the carbohydrates from photosynthesis, combines them with oxygen to make chemical energy. In plants this chemical energy is called ATP. The by products of plant respiration are carbon dioxide and water. ATP is used by the plant to power all plant growth and development. Respiration is like us digesting our food.

Comparison

Photosynthesis

- Produces food
- Stores energy
- Uses water
- Uses carbon dioxide
- Releases oxygen
- Occurs in sunlight

Respiration

- Uses food
- Releases energy
- Produces water
- Produces carbon dioxide
- Uses oxygen
- Occurs in the dark and light

IOWA STATE UNIVERSITY
University Extension

DEPARTMENT OF
HORTICULTURE

IOWA NURSERY &
LANDSCAPE
ASSOCIATION

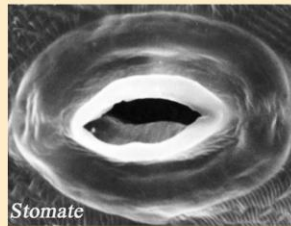
Sometimes the subtle differences between photosynthesis and respiration can be confusing. Hopefully this comparison table can help keep things clear.

Photosynthesis produces food, stores energy, uses water and carbon dioxide, releases oxygen, occurs in sunlight.

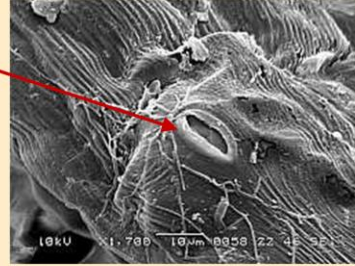
Respiration uses food, releases energy, produces water and carbon dioxide, uses oxygen, occurs in both darkness and sunlight.

Transpiration

- Water vapor lost through leaves
 - Stomates
- Pulls nutrients and water up from roots



Stomata



IOWA STATE UNIVERSITY
University Extension

DEPARTMENT OF
HORTICULTURE

IOWA NURSERY &
LANDSCAPE
ASSOCIATION

When plants are transpiring, they are losing water vapor through the stomates in the leaves. Stomates are special leaf cells that can open and close to let water vapor out. This loss of water vapor through the leaves causes water and nutrients to be drawn up through the plant from the roots. Plants are columns of water that is constantly being lost through the stomates and replaced by the roots absorbing water from the soil. Transpiration is comparable to people sweating.

Fun Fact: A giant redwood tree will lose around 420 gallons of water every day through transpiration!

Environmental Conditions Impact on Plant Growth

- Water stress
 - Drought stress
 - Slows photosynthesis
- High wind pulls water from plant
- High relative humidity
 - Slows transpiration, water up-take

IOWA STATE UNIVERSITY
University Extension

DEPARTMENT OF
HORTICULTURE

IOWA NURSERY &
LANDSCAPE
ASSOCIATION

The processes of photosynthesis, respiration and transpiration are all interconnected; one process will slow or stop completely if the previous process has been slowed or stopped. Given what inputs are required for each process, we can look at how a shortage or excess of any single input would influence the continuation of the processes.

Let's start with water. A shortage of available water directly slows the process of photosynthesis. Slowing photosynthesis means that all other plant growth and development processes will slow down too. Water stress can be caused by drought-like conditions or high wind situations where the water is being pulled from the plant before it can be used. Related to water stress is high relative humidity. High relative humidity means that the air round the plant cannot absorb any more water vapor. It therefore slows the plant's water up-take because transpiration is stopped.

Think about how the other factors required by plants to grow, will change when humans manipulate the growing environment. What about light? What about carbon dioxide and the greenhouse effect?

Test Your Knowledge

Match the name of each phase with the inputs and outputs in the self-test.

IOWA STATE UNIVERSITY
University Extension

DEPARTMENT OF
HORTICULTURE

IOWA NURSERY &
LANDSCAPE
ASSOCIATION

Match the name of each phase with the inputs and outputs in the self-test.

That concludes this module.

IOWA STATE UNIVERSITY
University Extension

DEPARTMENT OF
HORTICULTURE

IOWA NURSERY &
LANDSCAPE
ASSOCIATION

That concludes this module.