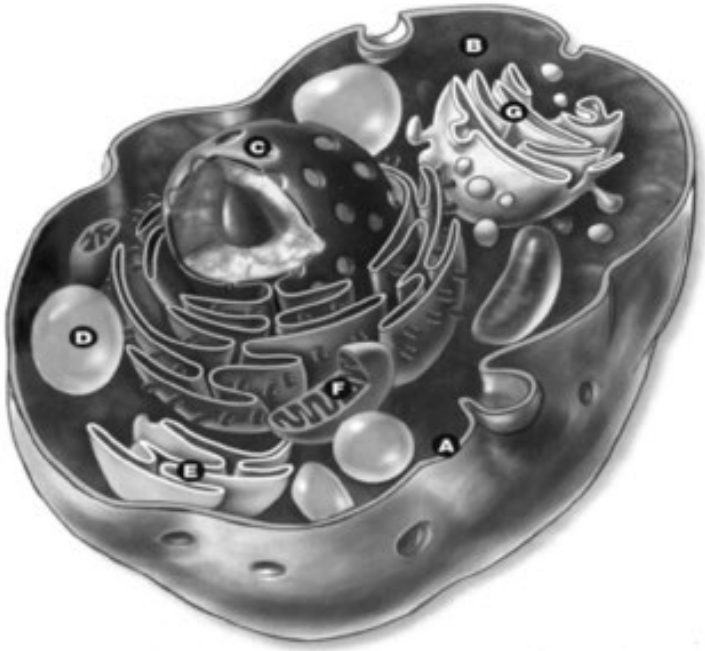
Science 10 Unit C: Biology

Photosynthesis and Cellular Respiration

In this unit, we have spent some time looking at the different parts of the cell:



You have noticed that parts of the cell are specialized to allow the cell to carry out all of the functions needed for life.

If we look at a larger organism, we find the same trend. Groups of cells are specialized to allow the organism as a whole to function.

Being a large multicellular structure has advantages:

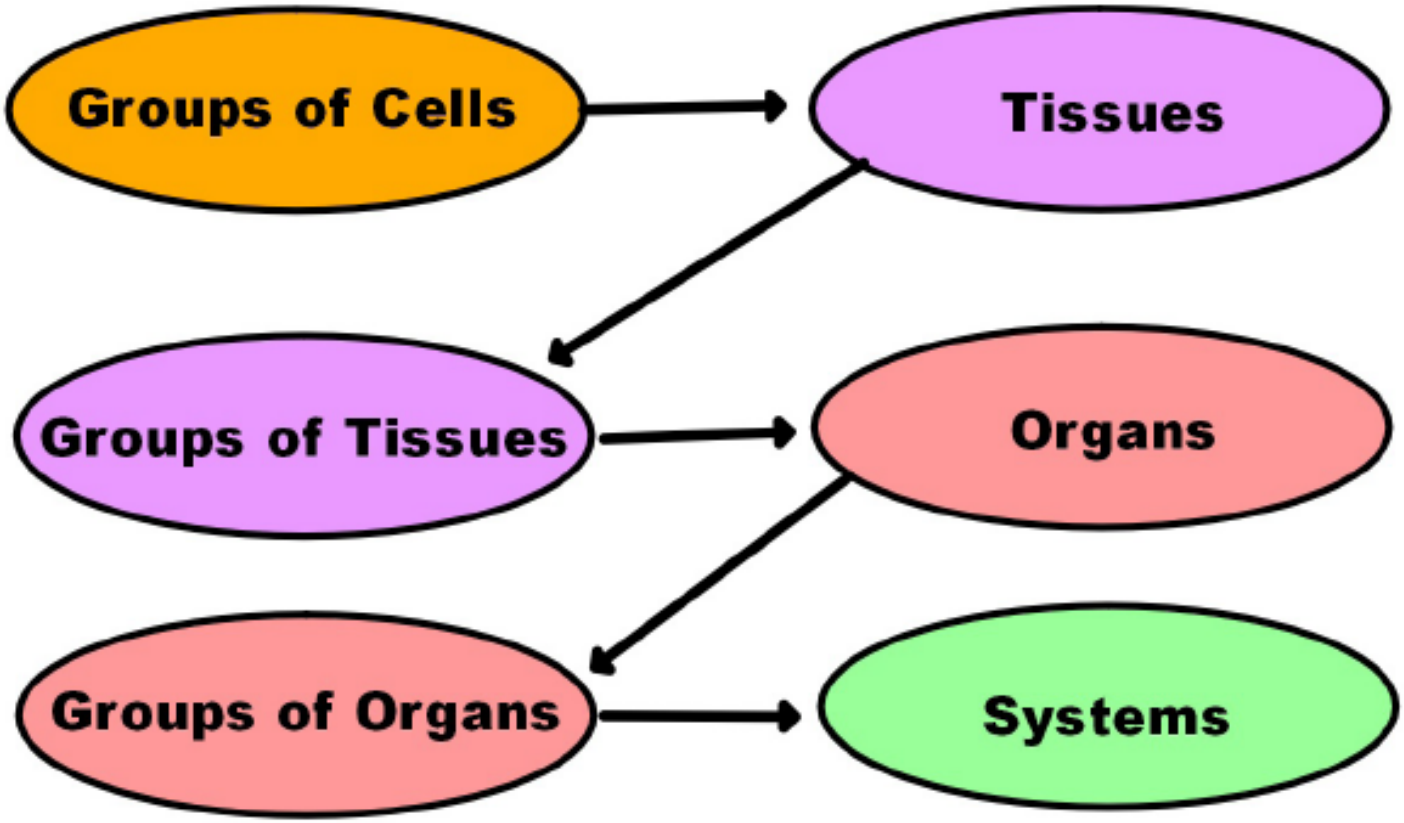
1. Division of labor: specialized cells for specific task

2. Size: multicellular organisms can grow larger as transport is handled by groups of smaller cells

3. Interdependence of cells: the life of the organism does not rely on one cell; if one cell dies (or even a group of cells), the organism will not die

Plant Structure

All life forms including plants are structured in the same general way:



Systems in a Plant

There are two main systems in a plant:

Shoot System

Root System

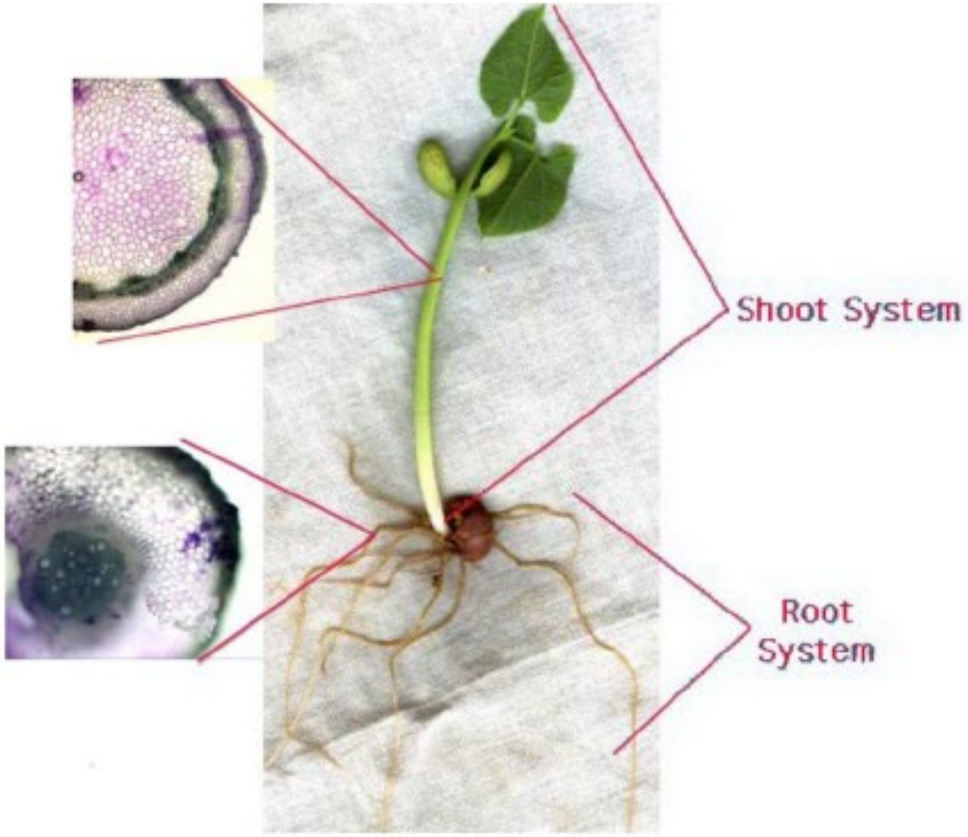
Shoot System

- **everything that is above the ground**: includes stem, leaves, buds, flowers, fruit and tubers (swollen stems that store food)

- specialized for gas exchange and photosynthesis

Root System

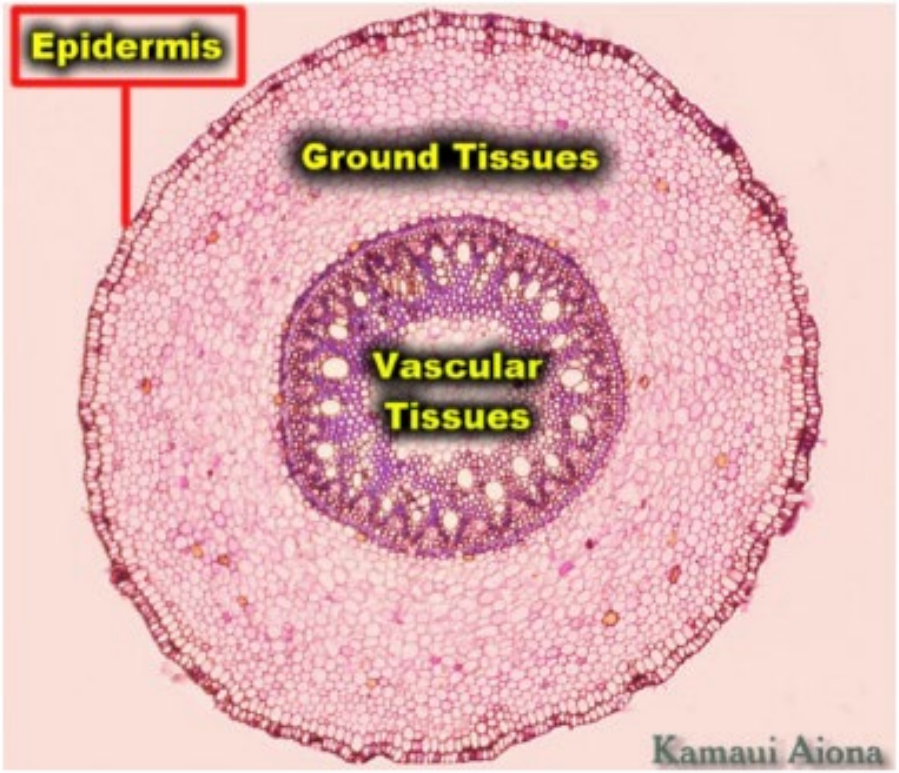
- everything that is below the ground includes aerial roots even though they are above ground
- specialized for transport of materials (water, minerals, nutrients)



Portions of the plant that grow very quickly (like the leaves on a tree) are called meristems.

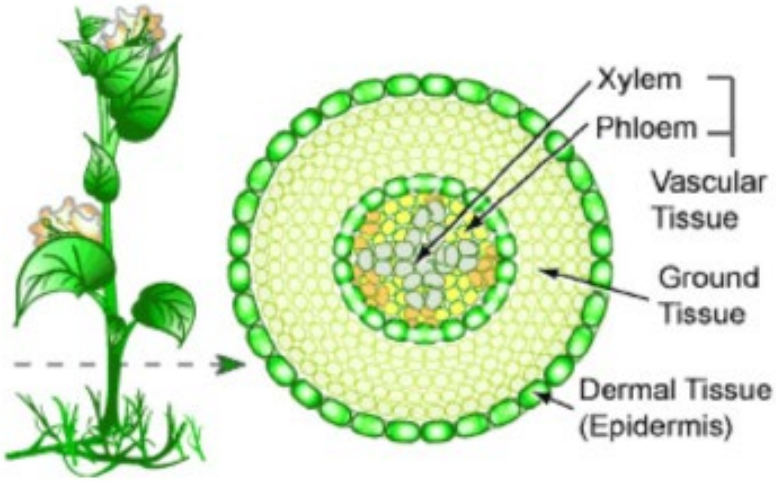
Each of these systems are made up of tissues; we study three main types:

- dermal tissue
- ground tissue
- vascular tissue



Dermal Tissue / Epidermis

- outer layer of cells that covers all herbaceous (non woody) plants generally one cell layer thick.



https://www.youtube.com/watch?v=GdW5SXWo7xc

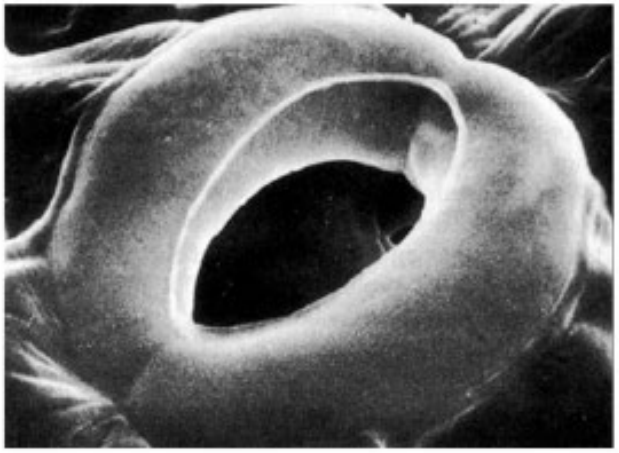
- in the shoot:
exchanges gases and secretes the cuticle (waxy substance that resists micro-organisms

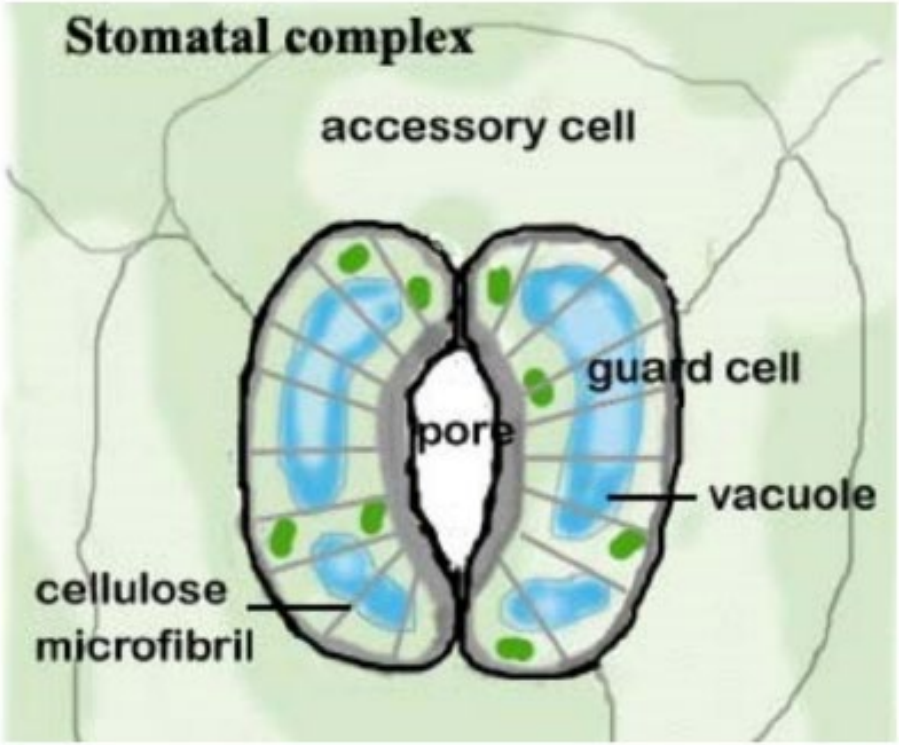
root system

- in the root: uptake of water and minerals from the soil

Dermal cells of the shoot system produce cuticle to protect the cells from water loss.

Guard Cells, cells on the underside of leaves, **form tiny pores called stomata** which allow for gas exchange.





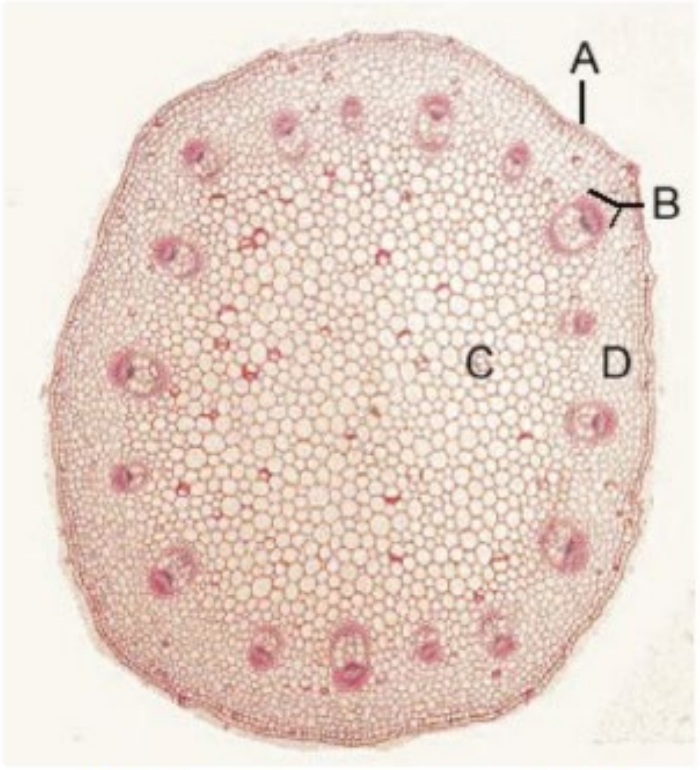
Other Cell Specialization

- Cells that form the root will specialize to become **root hairs**, tiny protrusions that **increase SA:V** and allow for better absorption

Ground Tissue

- layer beneath the epidermis, loosely packed together, air diffuses through the spaces

- Function:
  - in the stem, strength and support
  - in the roots: food and water storage
  - in the leaves: photosynthesis



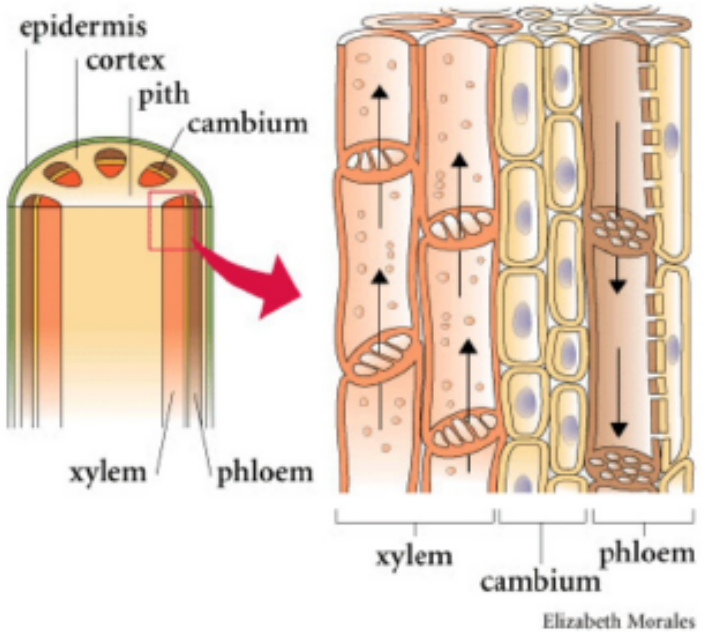
C and D are ground tissue

Vascular Tissue

A 2 part transport system:

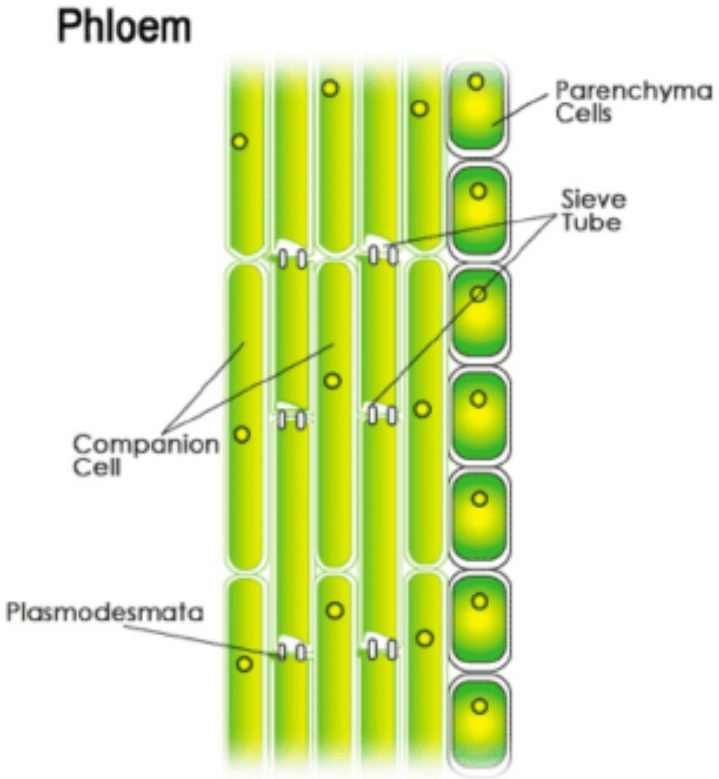
1. Xylem = moves water/minerals from roots to leaves.

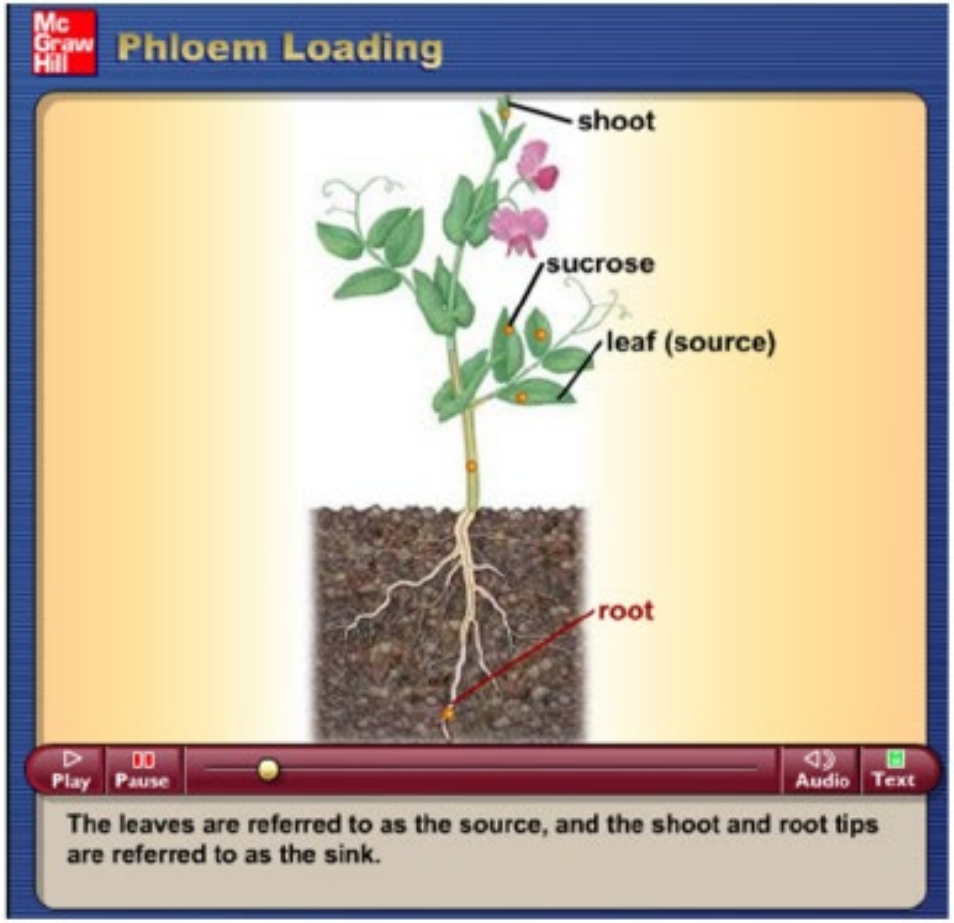
- **Thick walled tubes (cellulose/lignin).**
- **Non-living cells (like straws).**



2. Phloem = moves sugars from leaves to plant cells.

- **Living cells** with tiny holes.
- Sieve tube cells with companion cells (control activity).
- Sugars stored as starch.





Phloem Loading

Of course, all of these cells and systems need energy. Plants are unique in that they produce, convert and store their own energy through the process of photosynthesis and cellular respiration.

Storing Energy:

Photosynthesis

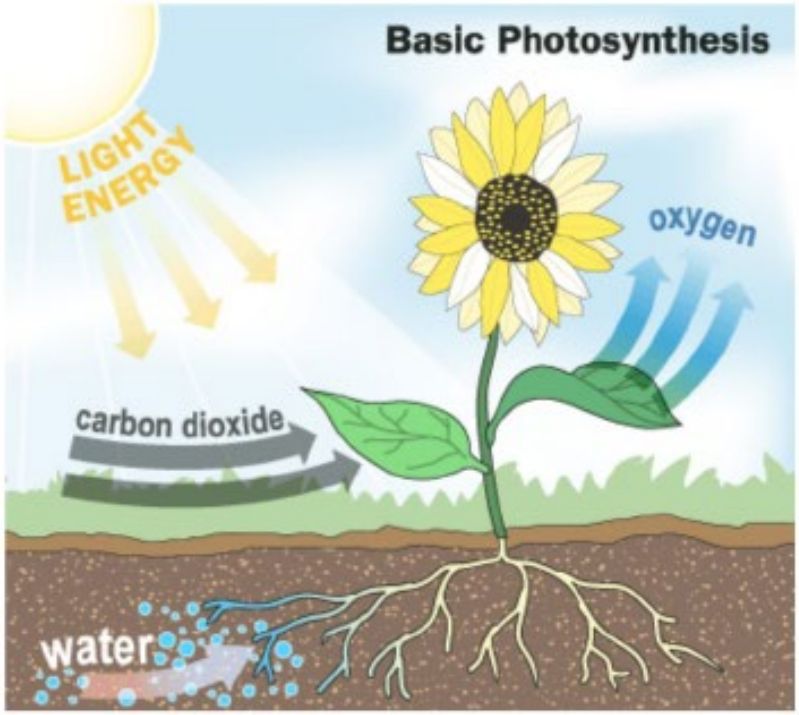
- the process by which plants produce food

While animals can move around to gather food, plants can not. They synthesize and store food (glucose) through the chemical process of photosynthesis.

The act of combining is a great way to think of photosynthesis.

Photosynthesis combines:

- sunlight (energy)
- $CO_{2(g)}$ (carbon dioxide from the atmosphere)
- $H_2O_{(l)}$ (from the roots)



...to create:

- $C_6H_{12}O_{6(s)}$ (glucose, a simple sugar)
- $O_{2(g)}$ (released to the atmosphere)

The chemical reaction is as follows:

$$\_\_\_\ CO_{2(g)} + \_\_\_\ H_2O_{(l)} + \text{energy} \longrightarrow \_\_\_\_\ C_6H_{12}O_{6(s)} + \_\_\_\_\ O_{2(g)}$$

$$6\ CO_{2(g)} + 6\ H_2O_{(l)} + \text{energy} \longrightarrow 1\ C_6H_{12}O_{6(s)} + 6\ O_{2(g)}$$

Note that in the chemical reaction, energy is being "put into" the equation. This is stored energy in the form of glucose in the plant.

Plants store this glucose (sugar) in a number of different locations:

stem

root

leaf

flower

seed

Photosynthesis requires the chemical chlorophyll to absorb sunlight.

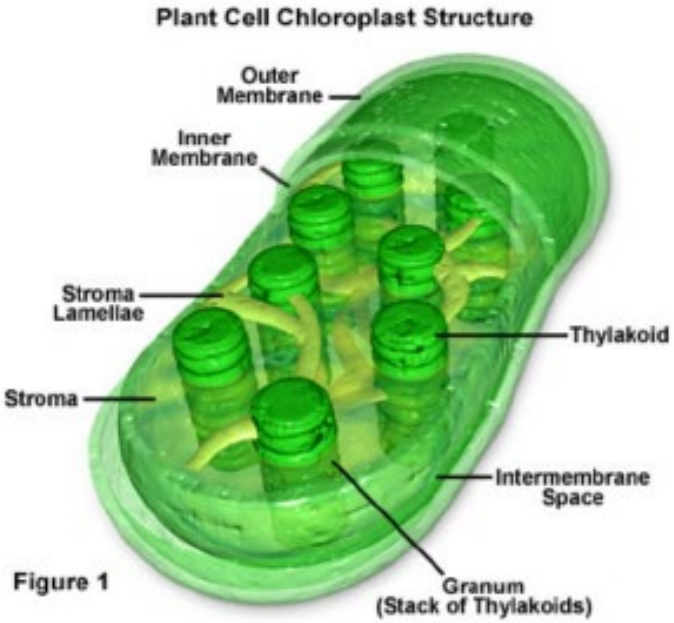


Figure 1

The process of photosynthesis takes place inside of the chloroplast in the plant cell. As such, it only takes place in plants as animal cells do not have chloroplasts.

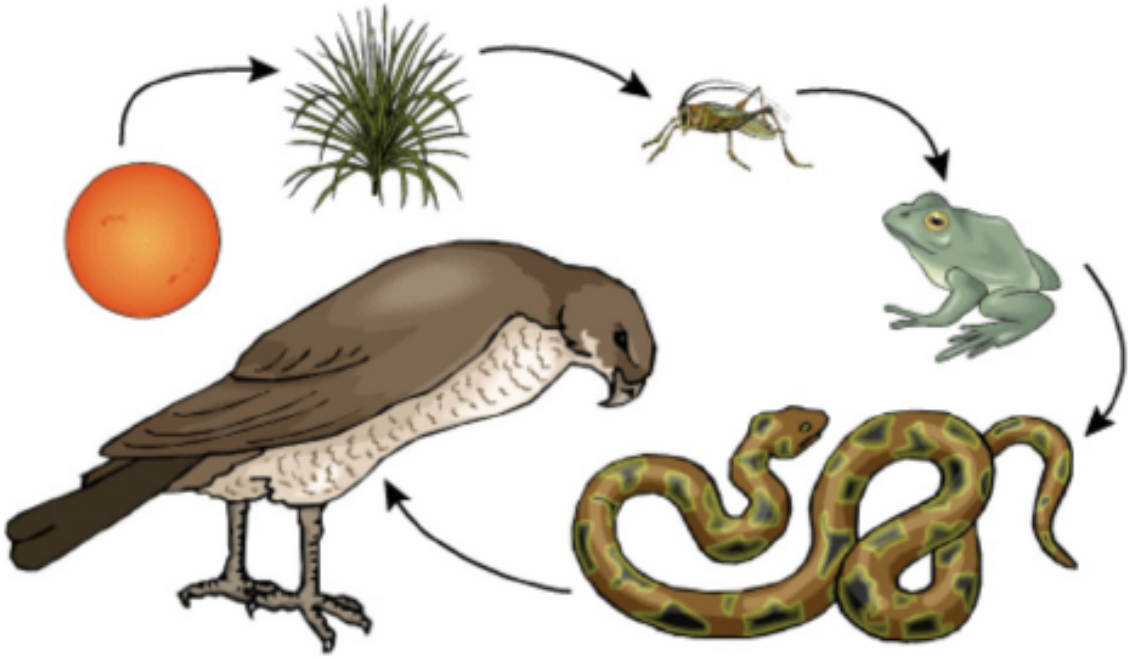
$$6\ CO_{2(g)} + 6\ H_2O_{(l)} + \text{energy} \longrightarrow 1\ C_6H_{12}O_{6(s)} + 6\ O_{2(g)}$$

This equation explains the role plants play on our planet: throughout the day when the sun is shining, they are constantly replenishing oxygen into the environment and reducing carbon dioxide levels.

Algae, a single-celled photosynthesising bacteria, creates much of the world's oxygen. Scientists hope that increasing and protecting these algal blooms will help curb the enhanced greenhouse effect.

$$6\ CO_{2(g)} + 6\ H_2O_{(l)} + \text{energy} \longrightarrow 1\ C_6H_{12}O_{6(s)} + 6\ O_{2(g)}$$

The equation also illustrates how we obtain all of our food energy: all living organisms are dependant on photosynthesis for energy or eat plants (or eat things that eat plants) to obtain this energy.



However, photosynthesis only creates stored energy, glucose.

+ water + CO_2 =

The plant cannot use this energy directly, as it is "packed up" for storage.

So we need some way to "unpack" the energy to a usable form...

Unpacking Energy:

Cellular Respiration

- converting glucose into usable energy

Note this is essentially the reverse of photosynthesis:

$$1\,C_6H_{12}O_{6(s)} + 6\,O_{2(g)} \longrightarrow 6\,CO_{2(g)} + 6\,H_2O_{(l)} + \text{energy}$$

- cellular respiration converts glucose into ATP (adinosine triphosphate), a usable form of energy

- takes place in the mitochondria

- both plants and animals use cellular respiration

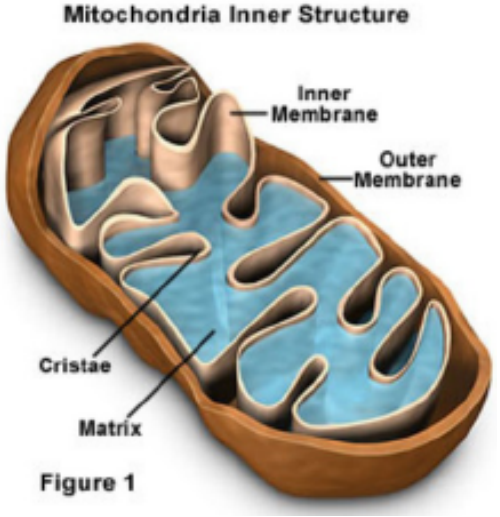
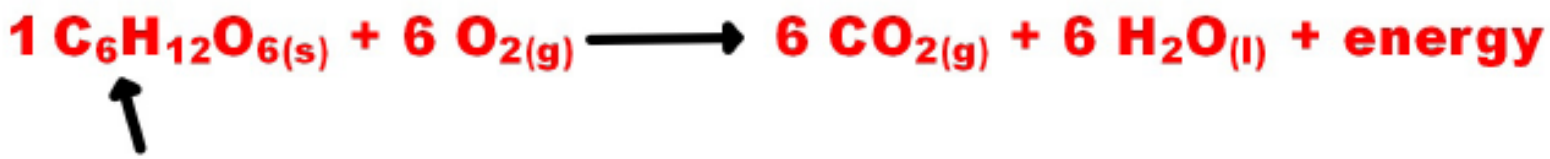


Figure 1



The glucose in this equation is the same stored energy coming from plants (or in the case of us carnivores, animals that eat plants) and can be stored as fats and sugars in the body.

While both plants and animals carry out cellular respiration, plants do so at a slower rate, so the amount of carbon dioxide produced by plants is negligible.