Botany is the branch of Biology that deals specifically with the study of plants. Botanists study the structure, growth, reproduction, metabolism, development, diseases, ecology, and evolution of plants.

The Cranberry harvest in New Jersey.

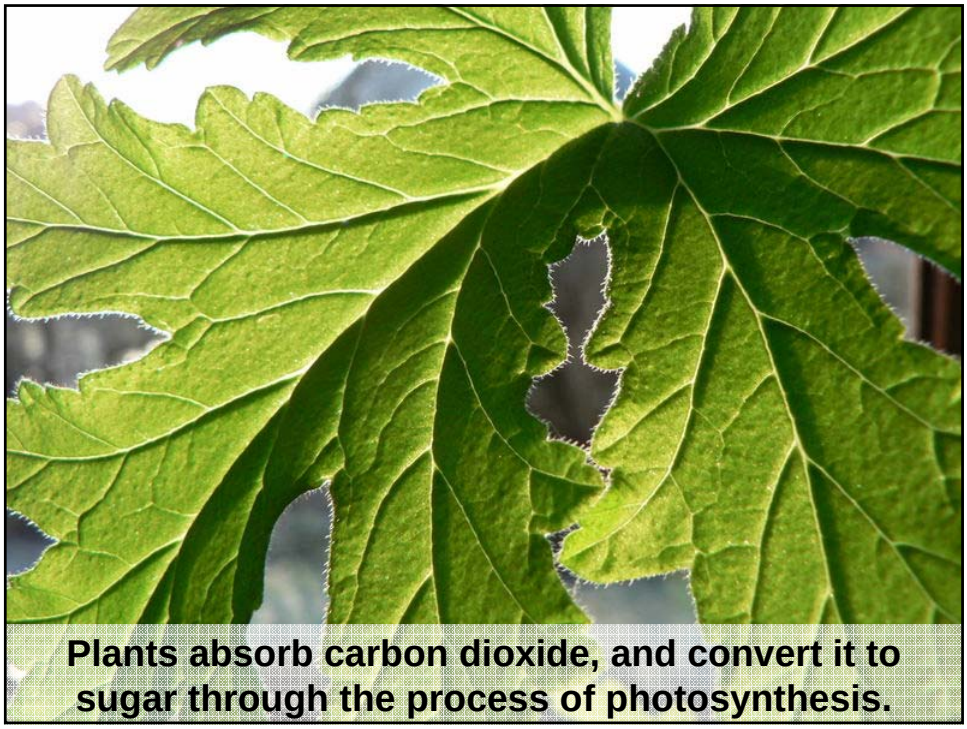
Why study plants?

- Plants are fundamental to life on earth.

From single-celled algae to the planet's largest living organism, they all contribute to our world's biodiversity. Plus they have tasty leaves and fruits

Plants are a fundamental part of life on earth.

They generate the oxygen, food, fibers, fuel and medicine that allow higher life forms to exist.



Plants absorb carbon dioxide, and convert it to sugar through the process of photosynthesis.

Understanding plants is crucial to the future of human society

A Better knowledge of plants will allow us to:

- Feed the world
- Understand fundamental life processes
- Utilize medicine and materials
- Understand environmental changes

An Introduction to Plants and Their Study

Key Concepts

- 1. Botany is the scientific study of plants.
- 2. Plants are essential to our lives.
- 3. Humankind has derived many benefits from the study of plants.
- 4. A plant is a living organism possessing many characteristics common to all living things.
- 5. A plant can be defined by a set of unique characteristics.

Attitude Adjustment

- If you were to take an opinion survey of student attitude towards plants at DHS it would most likely show that most students are not interested in learning about plants.
- Some students might comment that plants are boring
- Other students would probably laugh and say something stupid about “herbs”

- The truth is that the health of the plant communities does play a role in the quality of our lives.
- If nothing else we should care about plants because they are our food supply and without them we would die.
- Due to recent declines in crop productivity gains, there is concern that human population will become larger than global crop productivity.
- Botanical research is important if we want to improve crop productivity and help end global hunger.

Plants Produce Medicines

- 25% of the medicines on the UK market are derived directly from plants.
- Drugs made from fungi (fungi are not plants but traditionally fall under the category of Botany) prevent the rejection of transplanted hearts and other organs.
- The active ingredient in aspirin was originally derived from willow bark.
- The rosy periwinkle yields drugs which help treat diabetes.
- The study of plants' internal biochemistry - their production and use of vitamins, for example - can inform us as to the actions of those compounds on the human body.

Plants are Producers

- Virtually all of the food we eat comes from plants, either directly from staple foods and other fruit and vegetables, or indirectly through herbivorous livestock, which rely on plants for food.
- In other words, plants are at the base of nearly all food chains, what ecologists (and now you) call the first trophic level.

As a Signpost to Environmental Changes

Plants can also help us understand changes in on our environment in many ways.

- Plant responses to ultraviolet radiation can help us monitor problems like the ozone depletion
- Analyzing pollen deposited by plants thousands or millions of years ago can help scientists to reconstruct past climates and predict future ones, an essential part of climate change research.
- Lichens, which are sensitive to atmospheric conditions, have been extensively used as pollution indicators.

- In many different ways plants can act as an early warning system alerting us to important changes in our environment.
- In addition to these practical and scientific reasons, plants are extremely valuable as recreation for millions of people who enjoy gardening, horticultural and culinary uses of plants every day.

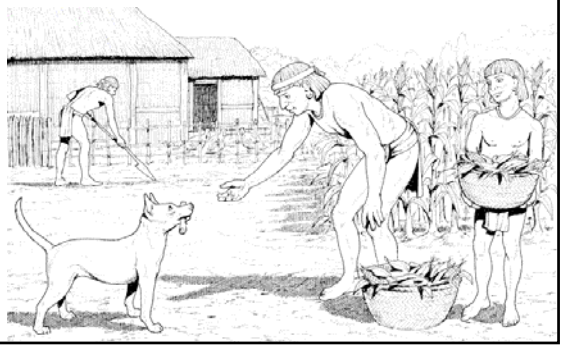
Plants Have Influenced Civilization

Plants Have Influenced Civilization

- **It was humanity's switch from nomadic hunting and gathering to a village centered agrarian society over 12,000 years ago that allowed us to develop into the modern urban centered civilization we now live in.**
- **The roots of farming began in the areas of present day Turkey and the Middle East.**

The secure food source of cereals was the basis of all of the early civilizations:

- Maize = Incas, Aztecs and Mayans
- Rice = China, Japan and India
- Wheat = Egypt, Rome, Greece and Mesopotamia



Society and Culture

- It was the development of farming that allowed for the domestification of animals such as goats and sheep.
- As our ancestors learned by trial and error which plants needed to be planted during what time of year, they also began to understand ecology.
- They also began to exert a artificial selection pressure on plants, as they choose the plants with the traits we found desirable (number of kernels, flavor. etc)

Food Calories

- Most of the calories in our diet come from cereals such as wheat.
- Nearly 90% of our daily calories come from foods in the following categories:
  - Grains- wheat, rice, corn, oats
  - Tubers and root crops- potato, yams, sweet potato, cassava
  - Sugar crops- sugarcane, sugar beets
  - Protein seeds- beans, soybeans, peas, lentils, chick peas, peanuts
  - Oil seeds- olives, soybeans, peanuts, coconut
  - Fruits- citrus, mango
  - Vegetables- cabbage, lettuce

Vegetarians Beware

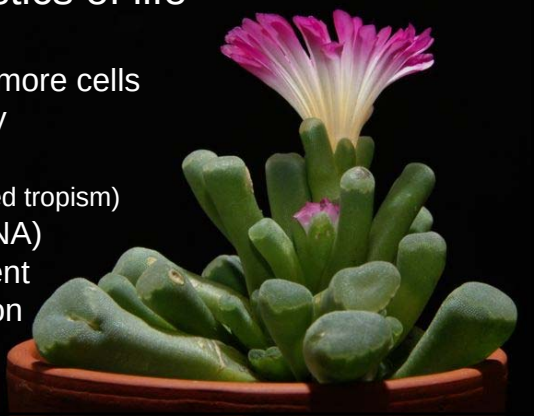
- **Vegetarians must make sure they combine a cereal (carbohydrates) with Legumes (protein) with leafy green vegetables (vitamins and minerals) and small amounts of oils for fats.**

What does it mean to be living?

Define Living

It is hard to quickly and precisely define life so instead we classify organisms as sharing the following characteristics of life

1. Organized- has one or more cells
2. Use and convert energy
3. Maintain Homeostasis
4. Respond to a stimulus (called tropism)
5. Reproduce (pass on DNA)
6. Growth and Development
7. Adaptation and Evolution



CHARACTERISTICS OF LIFE

A. Life is highly organized

1. Protons, Neutrons and Electrons make Atoms
2. Atoms make molecules
3. Monomers make up polymers
   - Amino acids, Fatty acids, Nucleotides, Monosaccharides
4. Macromolecules
   - Proteins, Lipids, Nucleic acids, Polysaccharides
5. Organelles
6. Cells (the smallest unit of life)
   - Organisms can be unicellular, colonial, or multicellular
7. Tissues (Groups of like cells that come together to perform a particular function)
8. Organs (Two or more tissue that come together to perform a particular function)
9. Organ systems (Two or more organs that come together to perform a particular function)
10. Organisms

CHARACTERISTICS OF LIFE

A. Life is highly organized - Continued

11. Populations
- Members of a specific species in the same area

12. Communities
- All species in the same area

13. Ecosystems
- All species in the same area interacting with each other and the non-living environment

14. Biomes
- Climatically controlled area with distinctive vegetation and a cycling of nutrients and materials

15. Biosphere
- All Biomes and their ecosystems

CHARACTERISTICS OF LIFE

B. Exchanges energy and materials with the environment

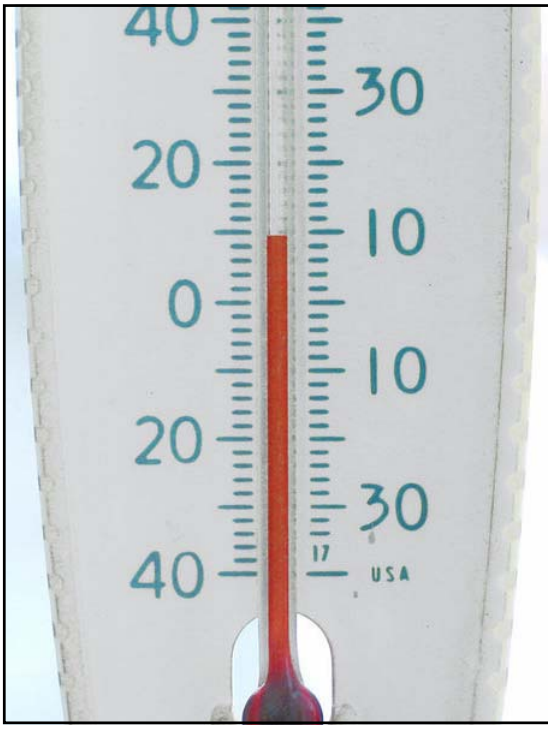
1. Energy is the ability to do work
    1) Types of work include mechanical, transport, metabolic

2. Energy is needed to maintain order- to fight entropy (the amount of disorder is always increasing)

3. Energy sources

    1) Phototrophs obtain energy from electromagnetic radiation (light)
        a) Includes plants, algae, and some bacteria
    2) Chemotrophs obtain energy from chemicals
        a) Animals, protists, fungi, and some bacteria

4. Materials
    1) Material may be broken down for energy by chemotrophs
    2) All organisms need materials for building blocks



C. Homeostasis

1. Internal environment is relatively constant

2. Many of the systems in our body are used to maintain homeostasis

Examples: body temperature around 98.6 in humans

CHARACTERISTICS OF LIFE

D. Respond to stimuli- (tropism)

1. The response of an organism to the external environment (stimuli) constitutes an organism's behavior

a) Most of plant behavior is geared towards obtaining sunlight and reproduction.

CHARACTERISTICS OF LIFE

E. Reproduce - pass on genetic information to offspring

1. Biogenesis theory = Life only comes from life
    a) Biogenesis theory explains the **UNITY of life**
2. Types of reproduction

a) Asexual

(1) One parent
(2) Offspring will be exactly the same as the parent and siblings (clones)

b) Sexual

(1) Exchange of gametes (eggs and sperm)
(a) Offspring receives some of its genes from each parent

CHARACTERISTICS OF LIFE

F. Develop and grow

a) Living growth- Assimilation- Becomes part of the organism
b) Nonliving growth- Accumulation- Dirty clothes, icicles, snow- no E used
c) Development- is the changing from infant to adult stage of life

G. Evolution and adaptation

1. Adaptation
a) Genetic modifications that make an organism better suited to its environment
2. Evolution
a) The process by which characteristics of a species change through time
3. Evolutionary adaptation explains the **diversity of life**.

Plants share these characteristics along with all living organisms.

- All living things must be able to:
  1. Organized- has one or more cells
  2. Uses energy
  3. Homeostasis
  4. Irritability
  5. Reproduction
  6. Growth and Development
  7. Adaptation and Evolution

Paul Cézanne - Still Life with a Skull

- Plants and Algae (a protist) are Autotrophs – meaning self feeding – so they are able to produce their own sugars using photosynthesis to fuel cellular respiration.
- Fungi and Animals are heterotrophs and they must obtain sugars from their environment to conduct cellular respiration.
- The major difference between a plant and an animal is the presence of two substances: chlorophyll and cellulose.

Plant Nutrition

Although plants are able to produce their own food they still need materials from the environment to survive

There are sixteen elements are absolutely necessary for normal plant growth.

Many of these elements are the same as those required by humans.

In addition to carbon, hydrogen, and oxygen, which the plant gets from the air and water, another thirteen elements are obtained from the soil.

These are usually divided into three classes: primary nutrients, secondary nutrients, and micronutrients.

In the greenhouse we will apply fertilizers to provide plants with some of these essential nutrients for optimal growth.

Non-mineral Nutrients

- **Carbon, Hydrogen, and Oxygen - also Nitrogen**
- Carbon comes from CO_2 out of the atmosphere and is the major structural element of organic compounds.
- Hydrogen comes from water and bonds to the carbon molecular skeleton.
- Oxygen comes from CO_2 and water and bonds to the carbon molecular skeleton.
- Carbohydrates (sugars, starches, cellulose, etc) for the basic building blocks of cells and are made up of these three elements. These molecules are converted to more complex molecules (amino acids, proteins, lipids, enzymes, etc) by the addition of other nutrient elements.

Macronutrients

- **Primary nutrients (fertilizer elements) - Nitrogen, Phosphorus, and Potassium**
- Nitrogen is a primary constituent of amino acids and proteins. Since enzymes and membranes are protein-based structures, a nitrogen deficiency will curtail plant growth.
- Phosphorus is a constituent of ATP and ATP, the energy-containing molecules that are present in respiration and photosynthesis.
- Potassium is a salt. It is very mobile in the plant and seems to be involved in transport operations.

Secondary nutrients

- **Calcium, Magnesium, Sulfur**
- Calcium is a constituent of cell walls. Since cell division requires the building of new cell wall material, a deficiency of calcium will show up in the meristems.
- Magnesium is a component of chlorophyll. It is also present in vitamins.
- Sulfur is a component in certain amino acids and vitamins.

Micronutrients

- **Boron, Chlorine, Copper, Iron, Manganese, Molybdenum, and Zinc**
- Boron - flowering, fruiting, and cell division
- Chlorine -
- Copper - Enzymes that are involved in the synthesis of chlorophyll
- Iron - A catalyst in chlorophyll formation
- Manganese - synthesis of chlorophyll
- Molybdenum - protein synthesis
- Zinc - needed for auxin and starch formation

Question

- Suppose you had to describe what a plant was to a person who never saw a plant before, but was generally familiar with biological concepts and processes.
- In small groups develop the most descriptive (detailed) definition of a plant that you can.

Plants are

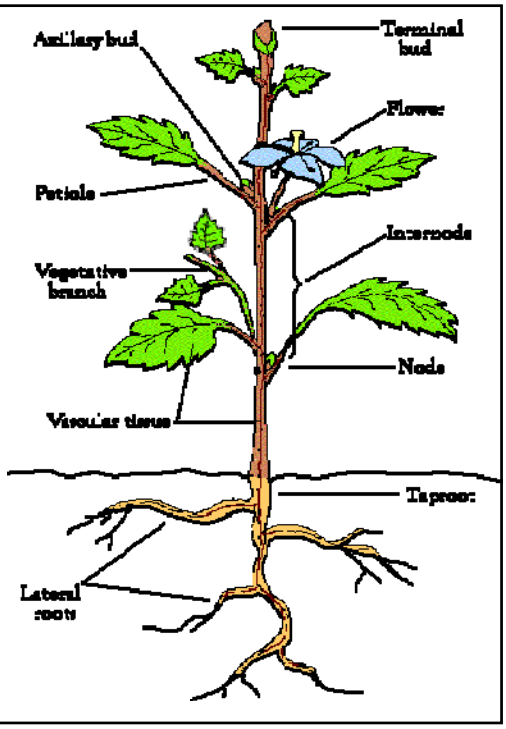
- Eukaryotes – Has cells with a membrane enclosed nucleus
- Autotrophs/ Producers/ Phototrophs
- Filled with the green substance chlorophyll
- Protected by cell walls made of cellulose

Basic Body Plan of an Angiosperm

The plant body is divided into a **root** system and a shoot or **stem** system that is connected by vascular tissue that runs throughout the plant

The root system of this dicot consists of a taproot and several lateral roots.
Shoots consist of stems, leaves, and flowers.

The leaf is attached to a stem by a petiole.

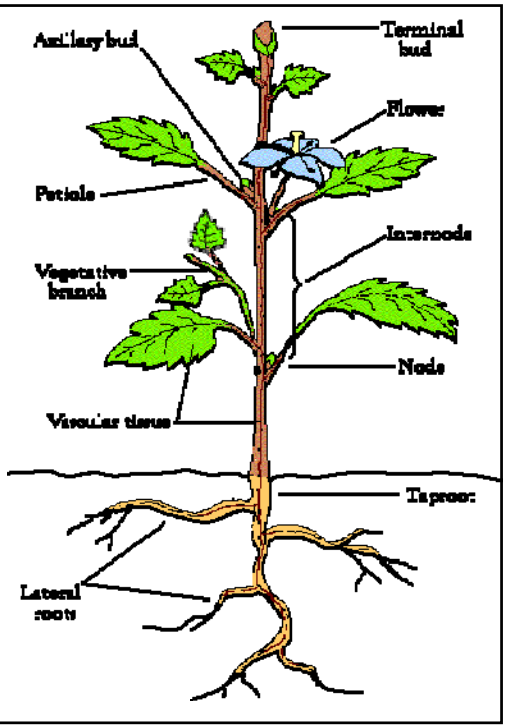


Basic Body Plan of an Angiosperm

Nodes, the regions of a stem where leaves attach, are separated by internodes.

At a shoot's tip is the terminal bud, the main growing point of the shoot.

Most buds are dormant, but they have the potential to develop into vegetative (leaf-bearing) branches or flowers (for sex)



Seeds

A seed is a small structure that contains an embryonic plant enclosed in a covering called the seed coat along with some stored food.

Seeds are created by plants after they have undergone fertilization.

There are two main types of seeds:

Monocots- Are seeds where the embryo has one cotyledon or seed leaf. Corn is a moncot.

Dicots- Where the embryo has two cotyledons. Beans are Dicots.

All seeds produce a radicle (embryonic root).

Roots

- Roots have several main functions
- Anchorage: Hold the plant down
- Storage: Store materials like starch
- Absorption: Water and minerals
- Conduction: Transport H_2O to stems
- Reproduction: Create new life

Stems

- Stems have several main functions
- Support: The leaves and flowers
- Storage: Sugars and Water
- Conduction: Sugars and Water
- Reproduction: new life
- Photosynthesis: Succulents can skip the leaves and just use their stems to make food

Leaves

A leaf is typically an above-ground plant organ specialized for photosynthesis.

Functions of the leaf:

- Photosynthesis
- Gas exchange
- Transpiration
- Store food and water

Flowers

A flower is the reproductive structure found on flowering plants (called angiosperms).

The flower contains the plant's reproductive organs, and its function is to produce seeds through sexual reproduction.

Despite all their talents

- Plants are still at risk due to changing environmental conditions.
- Increased temperatures/ Longer winters
- Changing patterns of precipitation
- Acid rain/ Pollution
- Fires
- Insects
- Human activity

Plants at Risk

- There are approximately 25,000 plant species at risk of extinction in the wild today.
- Some 8,700 of these are trees – 10 percent of all those known to science.
- Malaysia has 681 threatened plant species, the greatest of any country. A large proportion of these are tropical timber trees.

Green pitcher plant

(Sarracenia oreophila)

A carnivorous plant.
It is native to the North america and is the most endangered of all Sarracenia species, its range limited to a handful of sites in northern Alabama, North Carolina, and Georgia. The Pitcher Plant traps insects using a tubular rolled leaf which collects digestive juices at the bottom.