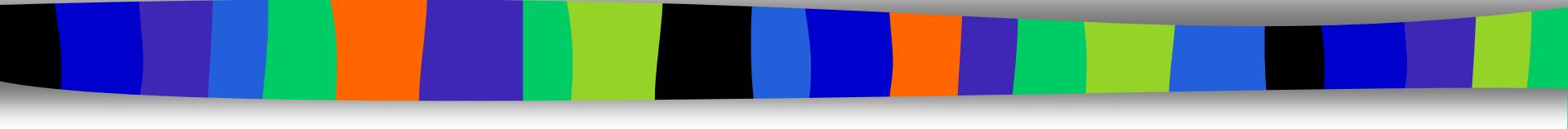
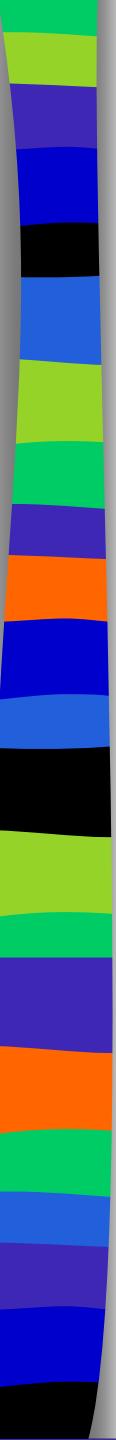


Unit B: Seed Germination, Growth, and Development



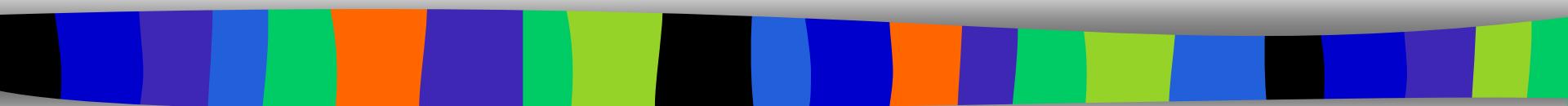
Lesson 4: Determining Nutrient Functions and Utilization



Terms

- Denitrification
- Leach
- Macronutrient
- Micronutrient
- Nitrification
- Nitrogen cycle
- Nitrogen fixation
- Nutrient deficiency
- Nutrient excess
- Nutrients
- Soluble salts

What are the 16 essential nutrients, their functions, and deficiency symptoms?

A decorative horizontal bar at the bottom of the slide consists of a series of colored squares in various sizes and colors, including black, blue, purple, green, and orange, arranged in a repeating pattern.

- Certain chemical elements, called **nutrients**, are essential for plant growth and development. Sixteen nutrients have been identified as being essential for plant growth.

- A little phrase can be used to help memorize the 16 essential elements for plant growth. It is “C HOPKNS CaFe Managed By Mine CuZn, Mo and Claude” It represents the following: Carbon (C), Hydrogen (Hopkns), Oxygen (hOpkns), Phosphorus (hoPkns), Potassium (hopKns), Nitrogen (hopkNs), Sulfur (hopknS), Calcium (CaFe), Iron (CaFe), Magnesium (Managed), Boron (By), Manganese (Mine), Copper (CuZn), Zinc (CuZn). Molybdenum (Mo), and Chlorine (Claude).



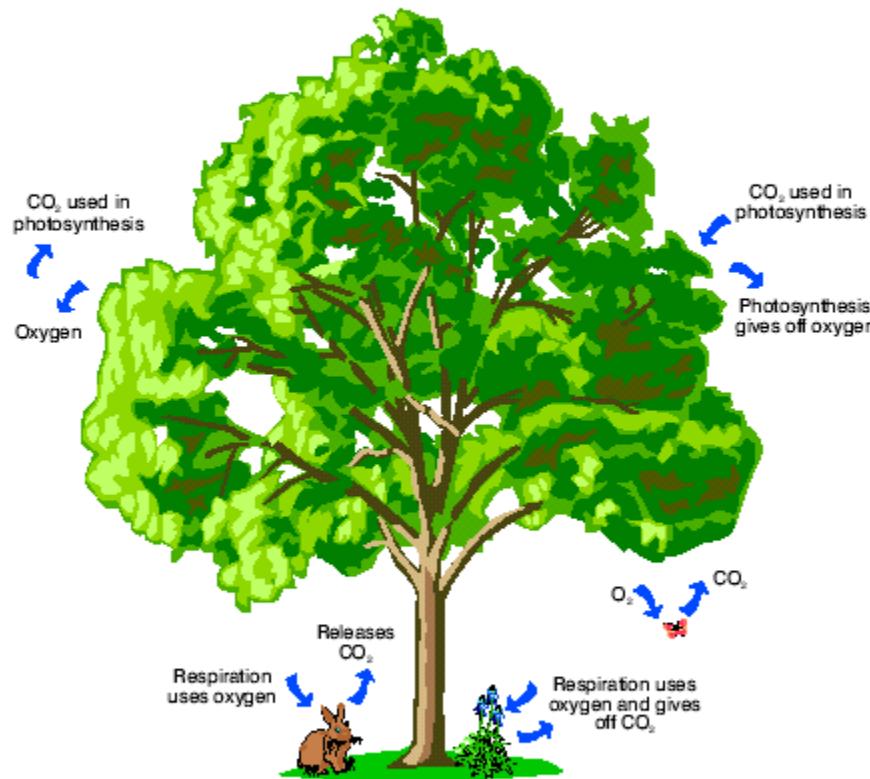
Plant growth, fueled by cellular respiration, takes place primarily at night when photosynthesis is shut down. With signals from hormones, enzymes are produced. Each enzyme has a specific job. The enzymes break down sugars and recombine them with nitrogen and other nutrients. Many complex products result including, starches, pectin, lignin, cellulose, lipids or fats, proteins, pigments, hormones, vitamins, and alkaloids and tannins that protect plants from pests and diseases.

- If a plant fails to receive the needed amount of nutrients, it will show signs of **nutrient deficiency**. Nutrient deficiencies most often result in an unhealthy plant appearance. Symptoms vary with the nutrient that is in short supply. Common symptoms of deficiencies include discoloration of the leaves, death of leaf tissue, and stunted growth. Because of the complex interactions of nutrients in plant processes, deficiency symptoms for different nutrients are often very similar

- High levels of nutrients or **nutrient excess** can cause damage to plants. Chemical fertilizers dissolved in water are referred to as **soluble salts**. Nutrient excess involves the build up of soluble salts that have a burning effect on plant roots.



THE OXYGEN CYCLE



What are the nonfertilizer nutrients and their functions?

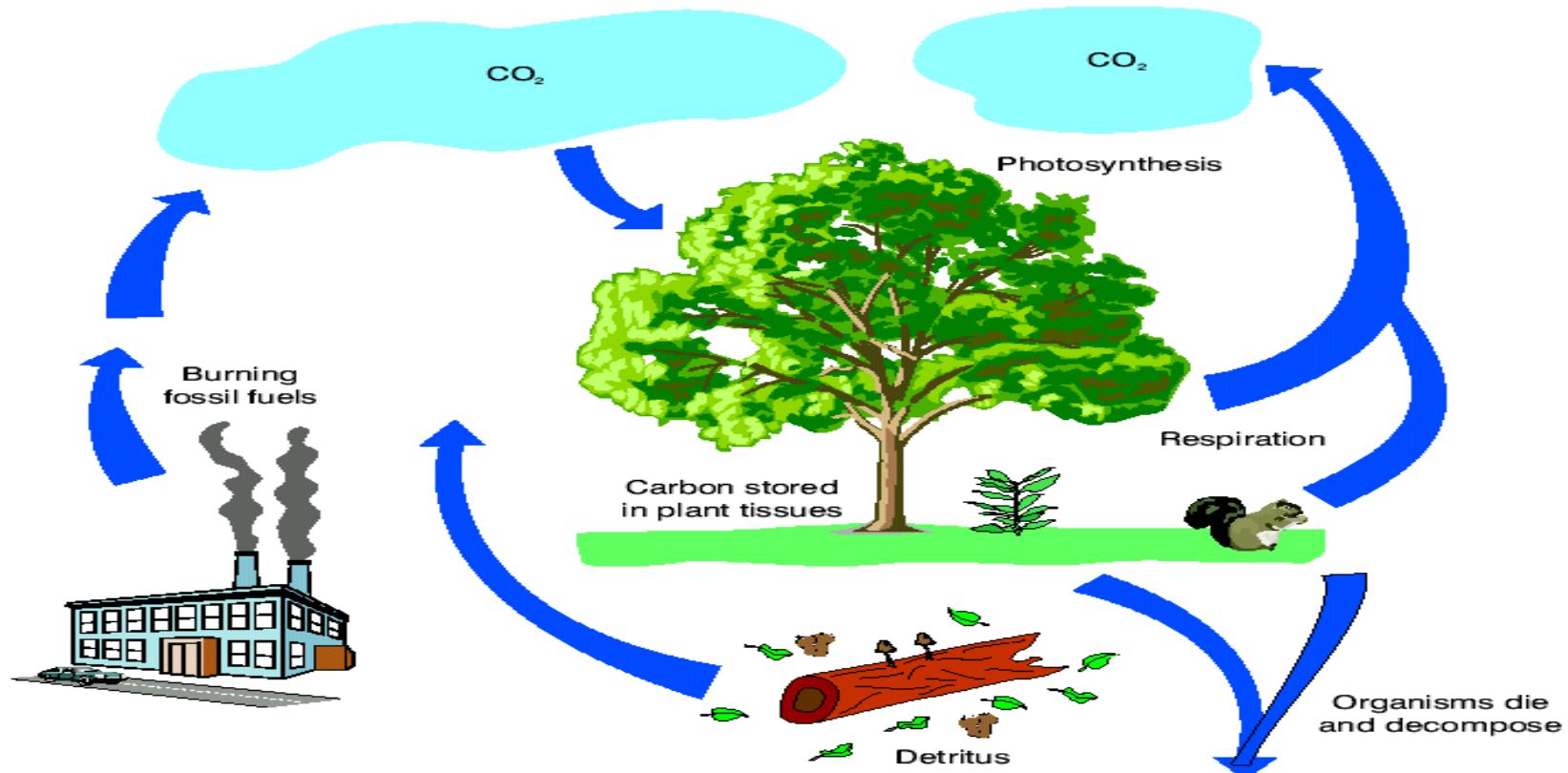
- Three nutrients make up 89 percent of a plant's tissues. They are carbon, hydrogen, and oxygen.
 - These are considered to be nonfertilizer nutrients because they are not given to plants as a fertilizer. Plants obtain these nutrients from air and water. Carbon comes from carbon dioxide; hydrogen from air and water; and oxygen from the air, water, and carbon dioxide. These nutrients are the building blocks for carbohydrates, proteins, fats, nucleic acids, and the many other compounds in plants.



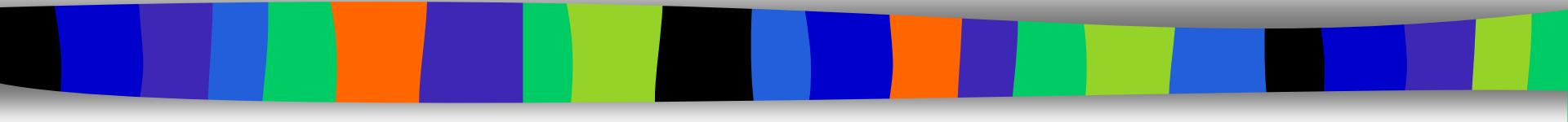
NONFERTILIZERS

Nutrient	Influence/Function
Carbon	Building block for carbohydrates, proteins, fats, nucleic acids
Hydrogen	Building block for carbohydrates, proteins, fats, nucleic acids
Oxygen	Building block for carbohydrates, proteins, fats, nucleic acids

THE CARBON CYCLE



What are primary macronutrients and their functions, and deficiency symptoms?



- **Macronutrients** are those elements used in great quantities by plants. There are six macronutrients. Those used in the largest amounts are called primary macronutrients. They are nitrogen (N), phosphorus (P), and potassium (K).

- Nitrogen is one of the most abundant and mobile elements on Earth. It is found in the air and the soil. Nitrogen is a part of chlorophyll. Plants lacking in nitrogen take on a yellowish color and appear stunted. Organic matter in the soil is the source of most nitrogen obtained by plants. Nitrogen is absorbed in the form of nitrate (NO_3^-) regardless of whether nitrogen is applied as a fertilizer or is from organic matter. **Nitrification** is the process carried out by soil bacteria in which ammonium (NH_4^+) from organic matter or chemical fertilizers is converted to nitrate. The nitrate becomes part of the soil solution and is absorbed by crops. Nitrates **leach** or pass through soils readily and may erode primarily through water runoff.

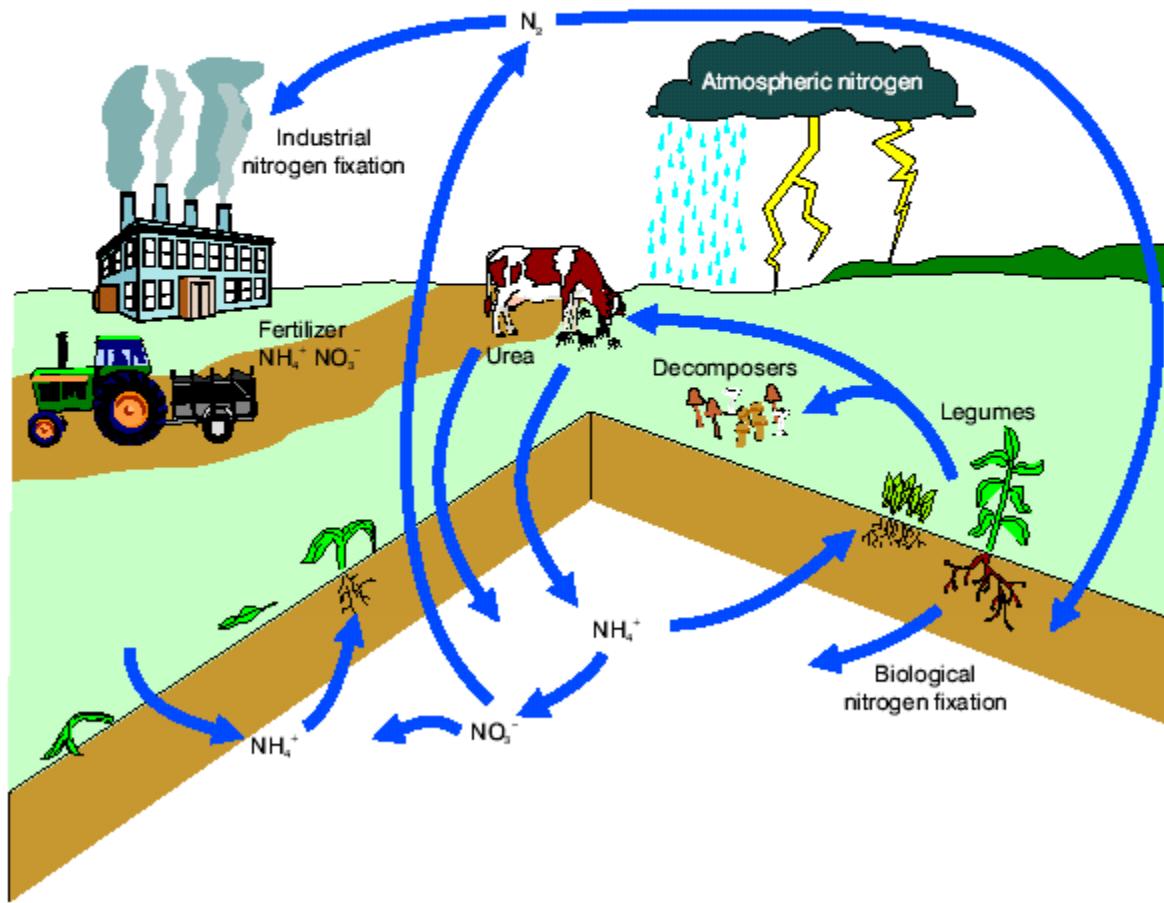
- Nitrate also converts to gaseous N₂ under wet soil conditions in a process known as **denitrification**. Nitrogen is therefore a nutrient that needs to be added to soils for optimal plant growth. Before plants can use nitrogen it must be removed from the atmosphere through nitrogen fixation or through the manufacture of chemical fertilizers. **Nitrogen fixation** is a natural process in which rhizobia bacteria in root nodules of legumes (alfalfa, clover, peas, beans, and vetch) convert nitrogen to a nitrate form. Legumes typically do not need nitrogen fertilizers because they make their own nitrogen supply. Nitrogen continually changes from usable nitrogen to atmospheric nitrogen. This flow of nitrogen is called the **nitrogen cycle**.

- Phosphorus plays a crucial role in the reproduction of seed plants. It is an important element for DNA. It promotes rapid root growth. Unlike nitrogen, phosphorus is very immobile in soil. However, since a large portion of a plant's phosphorus is found in seeds and fruit, the soil must be replenished annually. Deficiency symptoms include a purple tinge to the leaves.
- Potassium is necessary for the manufacture of starches and sugars. It assists in the plant disease and pest fighting mechanisms. It plays a role in the opening and closing of stomates. Symptoms of deficiency include a leaf tip burn and yellow or white streaks in the veins of the leaves.

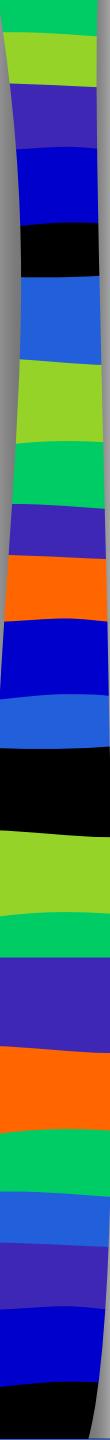
PRIMARY MACRONUTRIENTS

Nutrient	Influence/Function	Deficiency Symptom
Nitrogen	Produces stem and leaf growth; gives plants dark green color; synthesis of amino acids and proteins	Entire plant lighter green, lower leaves yellowing; slow or dwarfed growth
Phosphorus	Stimulates root development and growth; aids in cell division; encourages flower bud formation; improves winter hardiness; helps plants to a vigorous and rapid start	Purplish coloration to leaves and stems; stunted growth
Potassium	Increases plant vigor and disease resistance; aids in the transport of foods through the phloem; has key role in opening and closing stomata; thickens cell walls	Yellowing or death of tissues at tips and outer edges of older leaves

THE NITROGEN CYCLE



What are the secondary macronutrients and their functions, and deficiency symptoms?



Three macronutrients used to a lesser degree than nitrogen, phosphorus, and potassium are calcium (Ca), magnesium (Mg), and sulfur(S). Calcium, magnesium, and sulfur are said to be secondary macronutrients because moderate amounts are needed.

Calcium is needed for the formation of strong cell walls. It is instrumental in young, growing cells, especially in the root system. It also aids plants in using other nutrients. Calcium deficiencies appear as deformed, curled leaves.

- Magnesium is used in chlorophyll and is important to photosynthesis. It activates many plant enzymes. It is involved in the production of starches and fats and the movement of other nutrients throughout the plant. Deficiency symptoms include a yellowing of lower leaves and thin stems.
- Sulfur is needed for protein formation. It also stimulates root growth. Young leaves that have a light green color is a symptom of deficiency.

SECONDARY MACRONUTRIENTS

Nutrient	Influence/Function	Deficiency Symptom
Calcium	Maintains strength of cell walls; promotes early root growth	Short, much branched roots; young leaves at growing points die back
Magnesium	Essential for chlorophyll and photosynthesis; activator for many plant enzymes; aids nutrient uptake	Loss of green leaf color starting with bottom leaves
Sulfur	Stimulates root growth; needed for protein formation; gives green color	Young leaves light green with veins being lighter

What are the micronutrients and their functions, and deficiency symptoms?

- Those nutrients that are needed in smaller amounts by the plants, but are still essential to plant growth are called **micronutrients**.
The micronutrients are boron (B), copper (Cu), chlorine (Cl), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn).
 - The exact role of boron is unclear, but it appears to be essential for pollination and reproduction, cell division, and the transport of sugars. Young leaves look yellow and thick when the nutrient is lacking.



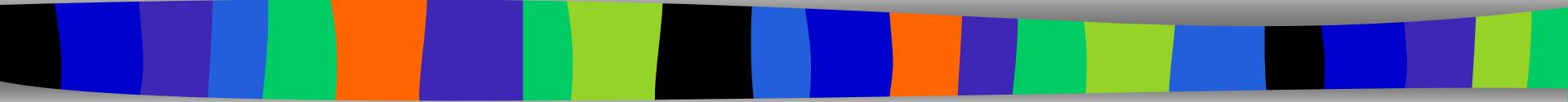
- Copper regulates several chemical processes including chlorophyll synthesis and respiration. A shortage results in the yellowing of leaves with the younger leaves affected first.
- Chlorine is involved in light reactions of photosynthesis. It aids root and shoot growth. Deficiency symptoms have not been recognized.
- Iron is important in chlorophyll formation and is a component of enzymes involved in photosynthesis, respiration, and nitrogen fixation. Young leaves yellow first. The veins remain green.

- Manganese is important in chlorophyll formation. It is part of enzymes involved in respiration and nitrogen metabolism. The symptom of deficiency is young leaves yellow first with the veins remaining green.
- Molybdenum is part of enzymes involved in nitrogen metabolism. It aids nitrogen fixation and protein synthesis. Deficiency symptoms appear as yellow older leaves and growth is stunted.
- Zinc is important in chlorophyll, auxin, and starch formation, and it is part of the enzymes that are involved in respiration. Older leaves that yellow and stunted growth are deficiency symptoms.

MICRONUTRIENTS

Nutrient	Influence/Function	Deficiency Symptom
Boron	Essential for pollination and reproduction; cell division; transport of sugars	Young leaves yellow and thick
Copper	Regulates several chemical processes; chlorophyll synthesis and respiration	Yellowing of leaves,, younger leaves affected first
Chlorine	Involved in light reactions of photosynthesis; aids root and shoot growth	Symptoms have not been recognized
Iron	Important in chlorophyll formation; component of enzymes involved in photosynthesis, respiration and nitrogen fixation	Young leaves yellow first; veins remain green
Manganese	Important in chlorophyll formation; part of enzymes involved in respiration and nitrogen metabolism	Young leaves yellow first; veins remain green
Molybdenum	Part of enzymes involved in nitrogen metabolism; aids nitrogen fixation and protein synthesis	Older leaves yellow; stunted growth
Zinc	Important in chlorophyll, auxin, and starch formation; part of enzymes involved in respiration; needed for auxin and starch formation	Older leaves yellow; stunted growth

Review/Summary



1. What are the 16 essential nutrients, their functions, and deficiency symptoms.
2. What are the nonfertilizer nutrients and their functions?
3. Identify the primary macronutrients and their functions, and deficiency symptoms.
4. What are the secondary macronutrients and their functions, and deficiency symptoms?
5. What are the micronutrients and their functions, and deficiency symptoms?