

## 31.1C: ESSENTIAL NUTRIENTS FOR PLANTS



Contributed by [Boundless](#)  
General Microbiology at [Boundless](#)

Approximately 20 macronutrients and micronutrients are deemed essential nutrients to support all the biochemical needs of plants.

### LEARNING OBJECTIVES

Distinguish among the essential nutrients for plants

### KEY TAKEAWAYS

#### KEY POINTS

- An element is essential if a plant cannot complete its life cycle without it, if no other element can perform the same function, and if it is directly involved in nutrition.
- An essential nutrient required by the plant in large amounts is called a macronutrient, while one required in very small amounts is termed a micronutrient.
- Missing or inadequate supplies of nutrients adversely affect plant growth, leading to stunted growth, slow growth, chlorosis, or cell death.
- About half the essential nutrients are micronutrients such as boron, chlorine, manganese, iron, zinc, copper, molybdenum, nickel, silicon, and sodium.

### KEY TERMS

- **micronutrient:** a mineral, vitamin, or other substance that is essential, even in very small quantities, for growth or metabolism
- **chlorosis:** a yellowing of plant tissue due to loss or absence of chlorophyll
- **macronutrient:** any of the elements required in large amounts by all living things

### ESSENTIAL NUTRIENTS

Plants require only light, water, and about 20 elements to support all their biochemical needs. These 20 elements are called essential nutrients. For an element to be regarded as essential, three criteria are required:

1. a plant cannot complete its life cycle without the element
2. no other element can perform the function of the element
3. the element is directly involved in plant nutrition

### MACRONUTRIENTS AND MICRONUTRIENTS

The essential elements can be divided into macronutrients and micronutrients. Nutrients that plants require in larger amounts are called macronutrients. About half of the essential elements are considered macronutrients: carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. The first of these macronutrients, carbon (C), is required to form carbohydrates, proteins, nucleic acids, and many other compounds; it is, therefore, present in all macromolecules. On average, the dry weight (excluding water) of a cell is 50 percent carbon, making it a key part of plant biomolecules.

Essential Elements for Plant Growth	
Macronutrients	Micronutrients
Carbon (C)	Iron (Fe)
Hydrogen (H)	Manganese (Mn)
Oxygen (O)	Boron (B)
Nitrogen (N)	Molybdenum (Mo)
Phosphorus (P)	Copper (Cu)
Potassium (K)	Zinc (Zn)
Calcium (Ca)	Chlorine (Cl)
Magnesium (Mg)	Nickel (Ni)
Sulfur (S)	Cobalt (Co)
	Sodium (S)
	Silicon (Si)

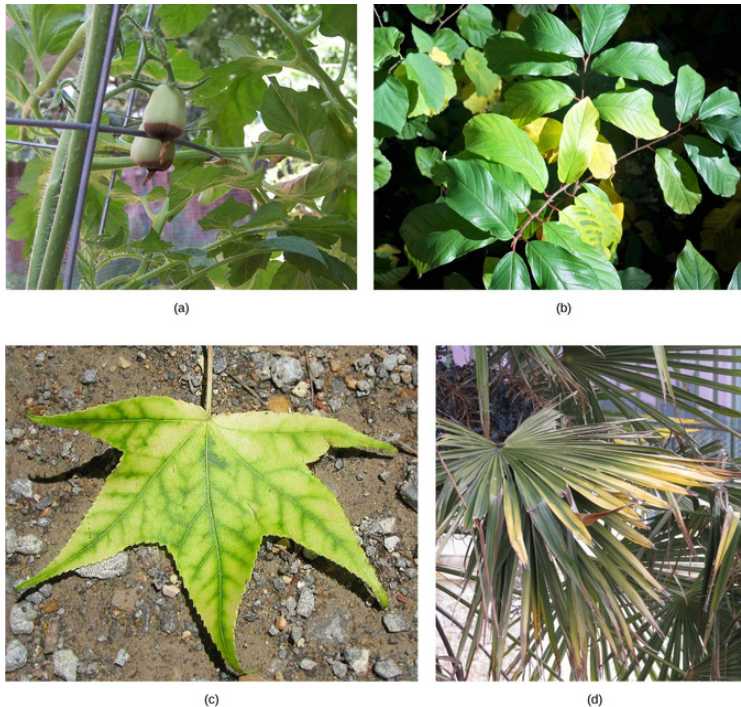
**Essential elements required by plants:** For an element to be regarded as essential a plant cannot complete its life cycle without the element, no other element can perform the function of the element, and the element is directly involved in plant nutrition.

The next-most-abundant element in plant cells is nitrogen (N); it is part of proteins and nucleic acids. Nitrogen is also used in the synthesis of some vitamins. Hydrogen and oxygen are macronutrients that are part of many organic compounds and also form water. Oxygen is necessary for cellular respiration; plants use oxygen to store energy in the form of ATP. Phosphorus (P), another macromolecule, is necessary to synthesize nucleic acids and phospholipids. As part of ATP, phosphorus enables food energy to be converted into chemical energy through oxidative phosphorylation. Light energy is converted into chemical energy during photophosphorylation in photosynthesis; and into chemical energy to be extracted during respiration. Sulfur is part of certain amino acids, such as cysteine and methionine, and is present in several coenzymes. Sulfur also plays a role in photosynthesis as part of the electron transport chain where hydrogen gradients are key in the conversion of light energy into ATP. Potassium (K) is important because of its role in regulating stomatal opening and closing. As the openings for gas exchange, stomata help maintain a healthy water balance; a potassium ion pump supports this process.

Magnesium (Mg) and calcium (Ca) are also important macronutrients. The role of calcium is twofold: to regulate nutrient transport and to support many enzyme functions. Magnesium is important to the photosynthetic process. These minerals, along with the micronutrients, also contribute to the plant's ionic balance.

In addition to macronutrients, organisms require various elements in small amounts. These micronutrients, or trace elements, are present in very small quantities. The seven main micronutrients include boron, chlorine, manganese, iron, zinc, copper, and molybdenum. Boron (B) is believed to be involved in carbohydrate transport in plants; it also assists in metabolic regulation. Boron deficiency will often result in bud dieback. Chlorine (Cl) is necessary for osmosis and ionic balance; it also plays a role in photosynthesis. Copper (Cu) is a component of some enzymes. Symptoms of copper deficiency include browning of leaf tips and chlorosis (yellowing of the leaves). Iron (Fe) is essential for chlorophyll synthesis, which is why an iron deficiency results in chlorosis. Manganese (Mn) activates some important enzymes involved in chlorophyll formation. Manganese-deficient plants will develop chlorosis between the veins of its leaves. The availability of manganese is partially dependent on soil pH. Molybdenum (Mo) is essential to plant health as it is used by plants to reduce nitrates into usable forms. Some plants use it for nitrogen fixation; thus, it may need to be added to some soils before seeding legumes. Zinc (Zn) participates in chlorophyll formation and also activates many enzymes. Symptoms of zinc deficiency include chlorosis and stunted growth.

Deficiencies in any of these nutrients, particularly the macronutrients, can adversely affect plant growth. Depending on the specific nutrient, a lack can cause stunted growth, slow growth, or chlorosis. Extreme deficiencies may result in leaves showing signs of cell death.



**Nutrient deficiency in plants:** Nutrient deficiency is evident in the symptoms these plants show. This (a) grape tomato suffers from blossom end rot caused by calcium deficiency. The yellowing in this (b) Frangula alnus results from magnesium deficiency. Inadequate magnesium also leads to (c) interveinal chlorosis, seen here in a sweetgum leaf. This (d) palm is affected by potassium deficiency.

## LICENSES AND ATTRIBUTIONS

### CC LICENSED CONTENT, SHARED PREVIOUSLY

- Curation and Revision. **Provided by:** Boundless.com. **License:** [CC BY-SA: Attribution-ShareAlike](#)

### CC LICENSED CONTENT, SPECIFIC ATTRIBUTION

- OpenStax College, Biology. October 17, 2013. **Provided by:** OpenStax CNX. **Located at:** <http://cnx.org/content/m44712/latest/?collection=col11448/latest>. **License:** [CC BY: Attribution](#)
- OpenStax College, Biology. November 22, 2013. **Provided by:** OpenStax CNX. **Located at:** <http://cnx.org/content/m44714/latest/?collection=col11448/latest>. **License:** [CC BY: Attribution](#)
- photosynthesis. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/photosynthesis>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- nutrient. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/nutrient>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- germinate. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/germinate>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- OpenStax College, Introduction. October 17, 2013. **Provided by:** OpenStax CNX. **Located at:** [http://cnx.org/content/m44712/latest/figure\\_31\\_00\\_01ab.jpg](http://cnx.org/content/m44712/latest/figure_31_00_01ab.jpg). **License:** [CC BY: Attribution](#)
- transpiration. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/transpiration>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- OpenStax College, Biology. October 17, 2013. **Provided by:** OpenStax CNX. **Located at:** <http://cnx.org/content/m44714/latest/?collection=col11448/latest>. **License:** [CC BY: Attribution](#)

- xylem. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/xylem>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- organic. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/organic>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- inorganic. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/inorganic>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- OpenStax College, Introduction. October 17, 2013. **Provided by:** OpenStax CNX. **Located at:** [http://cnx.org/content/m44712/latest/Figure\\_31\\_00\\_01ab.jpg](http://cnx.org/content/m44712/latest/Figure_31_00_01ab.jpg). **License:** [CC BY: Attribution](#)
- OpenStax College, Nutritional Requirements of Plants. October 17, 2013. **Provided by:** OpenStax CNX. **Located at:** [http://cnx.org/content/m44714/latest/Figure\\_31\\_01\\_01.jpg](http://cnx.org/content/m44714/latest/Figure_31_01_01.jpg). **License:** [CC BY: Attribution](#)
- OpenStax College, Biology. October 17, 2013. **Provided by:** OpenStax CNX. **Located at:** <http://cnx.org/content/m44714/latest/?collection=col11448/latest>. **License:** [CC BY: Attribution](#)
- Micronutrient. **Provided by:** Wikipedia. **Located at:** <http://en.wikipedia.org/wiki/Micronutrient>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- chlorosis. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/chlorosis>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- micronutrient. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/micronutrient>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- macronutrient. **Provided by:** Wiktionary. **Located at:** <http://en.wiktionary.org/wiki/macronutrient>. **License:** [CC BY-SA: Attribution-ShareAlike](#)
- OpenStax College, Introduction. October 17, 2013. **Provided by:** OpenStax CNX. **Located at:** [http://cnx.org/content/m44712/latest/Figure\\_31\\_00\\_01ab.jpg](http://cnx.org/content/m44712/latest/Figure_31_00_01ab.jpg). **License:** [CC BY: Attribution](#)
- OpenStax College, Nutritional Requirements of Plants. October 17, 2013. **Provided by:** OpenStax CNX. **Located at:** [http://cnx.org/content/m44714/latest/Figure\\_31\\_01\\_01.jpg](http://cnx.org/content/m44714/latest/Figure_31_01_01.jpg). **License:** [CC BY: Attribution](#)
- OpenStax College, Biology. November 22, 2013. **Provided by:** OpenStax CNX. **Located at:** <http://cnx.org/content/m44714/latest/?collection=col11448/latest>. **License:** [CC BY: Attribution](#)
- OpenStax College, Nutritional Requirements of Plants. October 17, 2013. **Provided by:** OpenStax CNX. **Located at:** [http://cnx.org/content/m44714/latest/Figure\\_31\\_01\\_03abcd.jpg](http://cnx.org/content/m44714/latest/Figure_31_01_03abcd.jpg). **License:** [CC BY: Attribution](#)