جامعة أم القرى
UMM AL-QURA UNIVERSITY

General Biology

Lecture (6):

Plant Form and Function

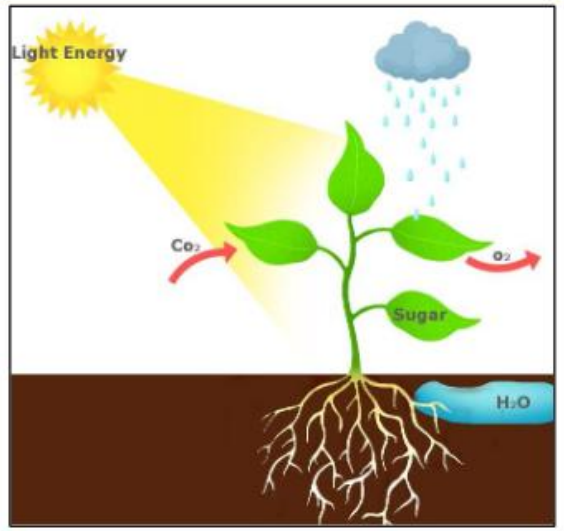
College of Applied Sciences
Biology Department

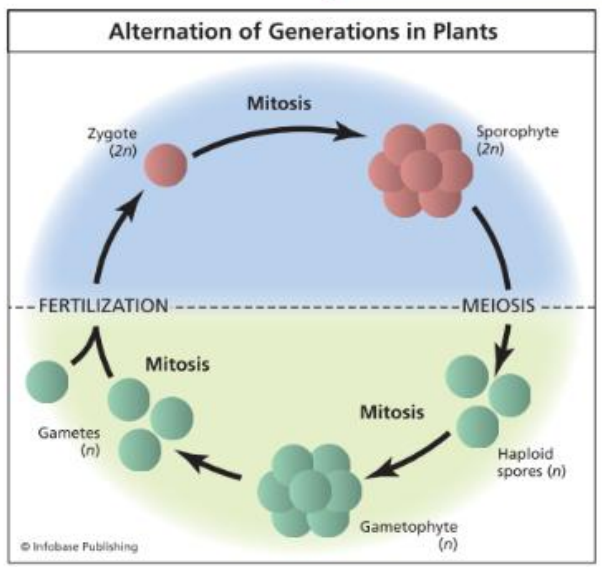
Outline

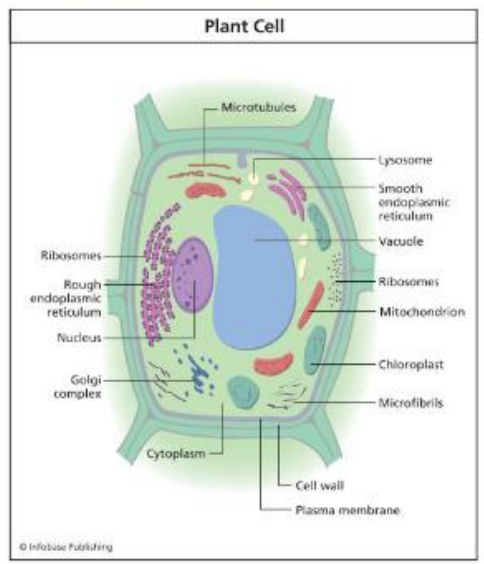
- Plant Characteristics
- Highlights of Plant Evolution
- Plant diversity
- Seed Plant structure [*seed, root, stem, leaf, flower, fruit*)
- Plant Nutrition and Soil Structure [*macronutrients micronutrients, soil, fertilizers*]
- Plant Responses to Internal and External Signals

Plant Characteristics

- **Autotrophic** (produce their own food by photosynthesis)
- **Non-motile**
- **Multicellular**
- **Eukaryotic** organisms
- Cell walls are composed of **cellulose**.
- Can **reproduce sexually and asexually.**
- **An alternation of generations occurs** (Gametophyte --> Sporophyte --> Gametophyte

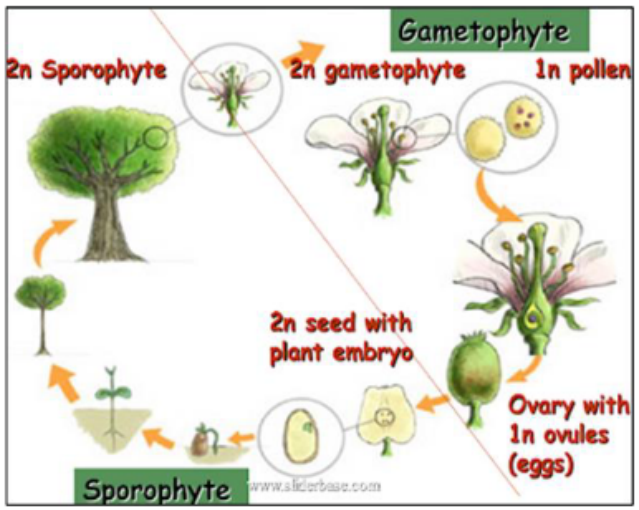


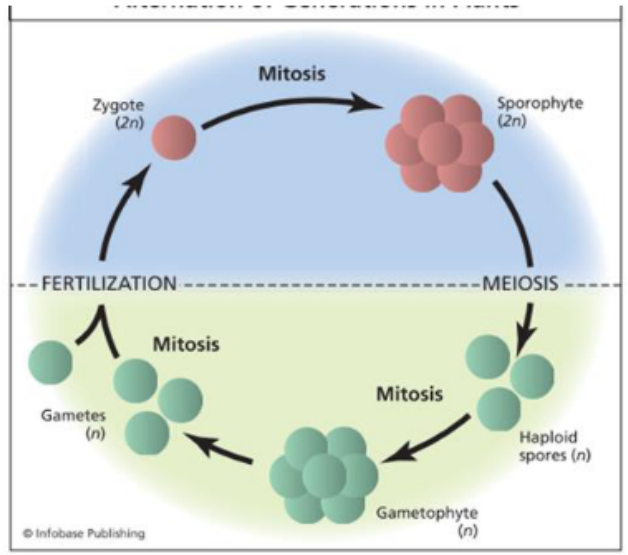




Alternation of Generations

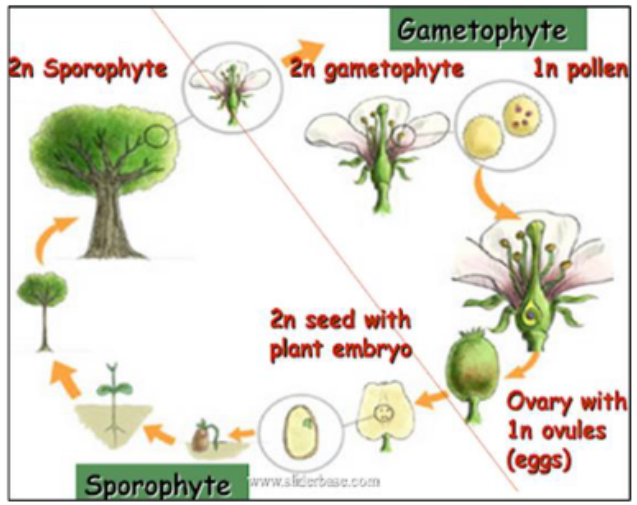
- The life cycle of any land plant has two distinct phases (**Gametophyte** and **Sporophyte**).
- The amount of time spent in each phase varies depending on the plant group.
- The first phase is called the gametophyte generation (phyte=plant, gameto=gamete).
- Gametophyte is a plant (multicellular, not just a single cell) that has a single set of chromosomes (**haploid**), which produces **gametes** via mitosis (egg and sperm cells), which are also **haploid**.

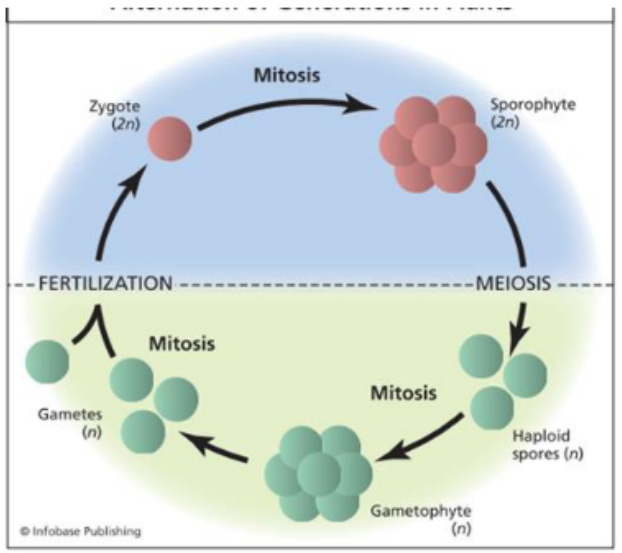




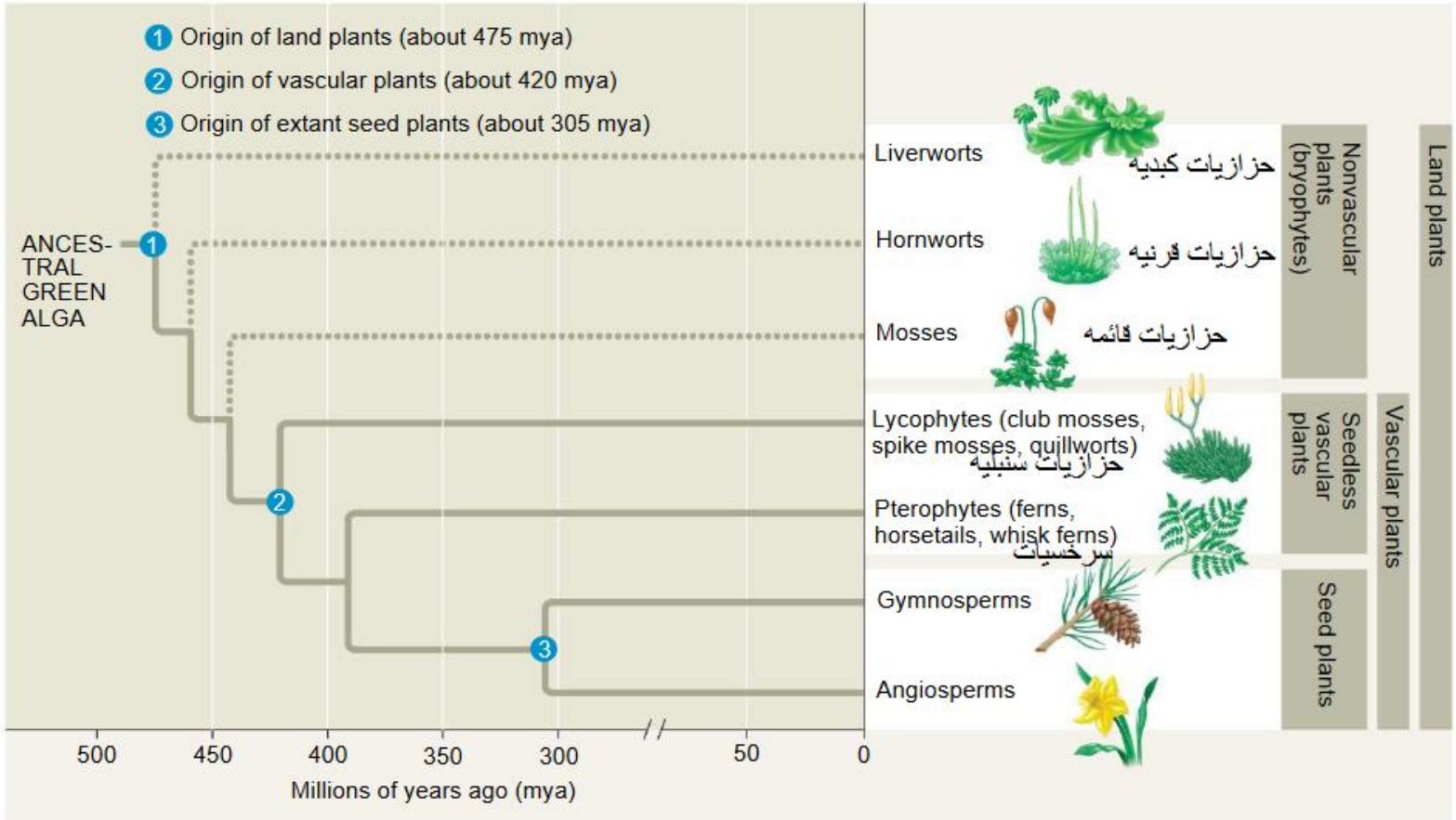
Alternation of Generations

- The second phase is called the sporophyte generation (phyte=plant, sporo=spore).
- Sporophytea is a plant (multicellular, not just a single cell) that has two sets of chromosomes (**diploid**), which is the result of the fusion of two gametes (sperm and egg), which produces **haploid spores** via **meiosis**.

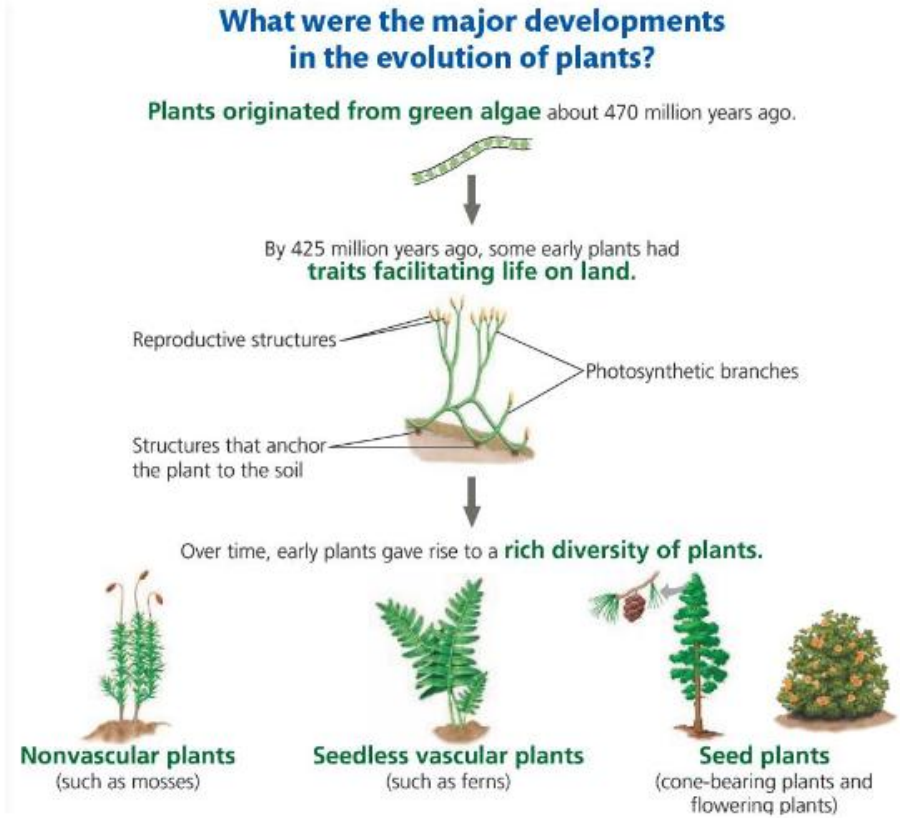




Highlights of Plant Evolution



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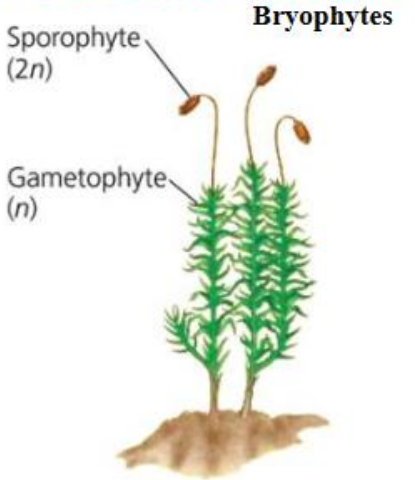
Plant diversity

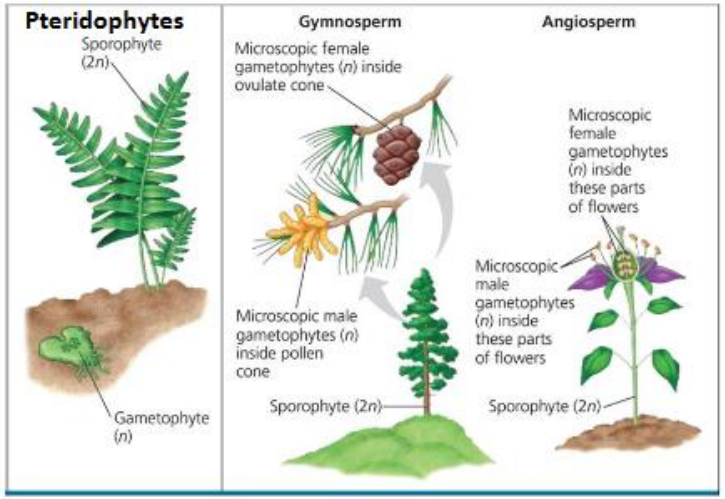




Land plants can be informally *grouped based on* the *presence or absence* of ***vascular tissue***.

Feature	Vascular Plants	Non-vascular Plants
Vascular system	They have a well-developed vascular system	They lack a specialised vascular system
Differentiation of body	They possess true roots, stem and leaves	They lack true roots, stems and leaves
Ploidy of main body	The main plant body is the diploid sporophyte	The main plant body is the haploid gametophyte
Vascular tissues	They contain complex vascular tissues, i.E. Xylem and phloem	They lack xylem and phloem
Size	They may grow very tall	They are small in size
Fertilisation	They may or may not require water for fertilisation	They require water for fertilisation
Examples	Pteridophytes, gymnosperms and angiosperms	Bryophytes





Seed plants

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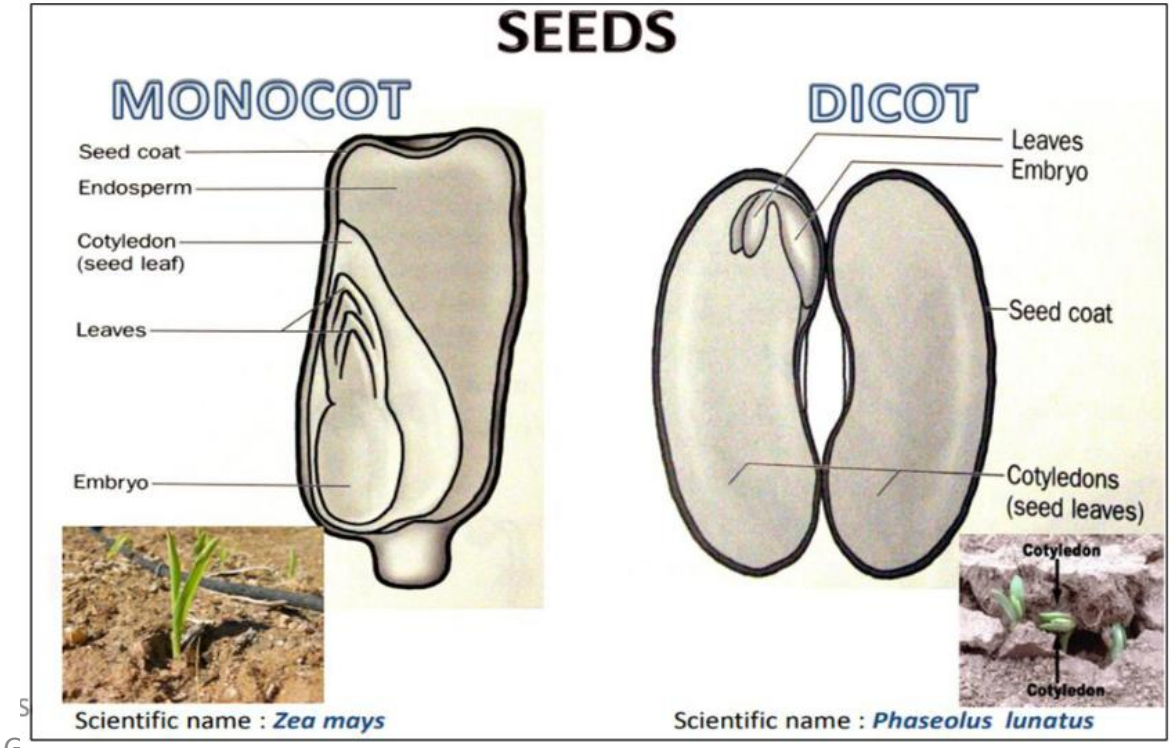
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Seeds and Mature seed structure

- **Seed** is a **small embryonic** plant in the **dormancy state**, that produce of sexual reproduction in flowering plants.

- **Mature seed structure:**

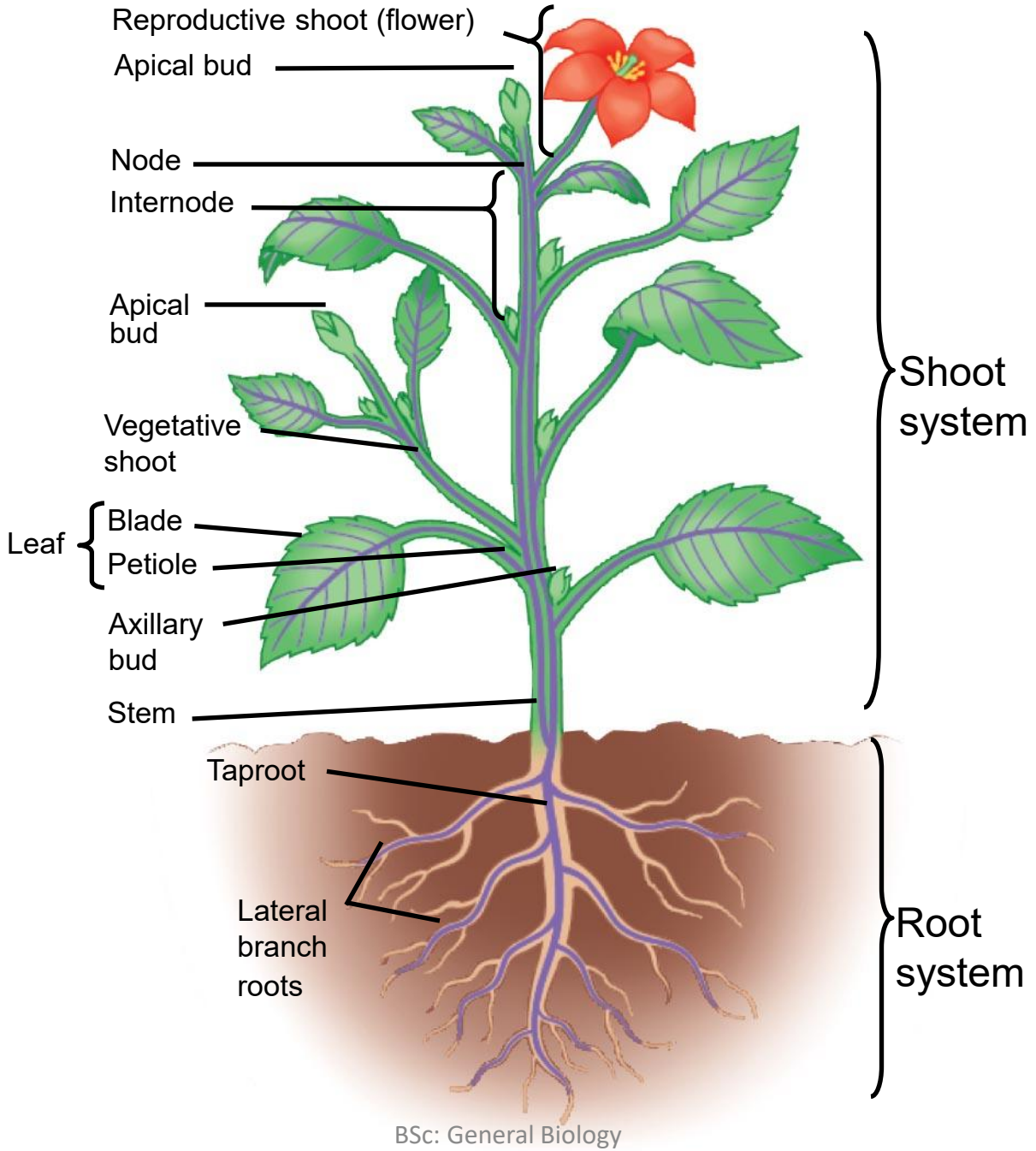
  1. Seed coat (testa)
  2. Embryo
  3. Cotyledons



The Plant Structure

- **Three** basic organs evolved**: roots, stems, and leaves.**
- They are organized into a **root system** and a **shoot system:**
- **Roots** rely on sugar produced by photosynthesis in the ***Shoot system***.
- **Shoots** rely on water and minerals absorbed by the ***Root system***.

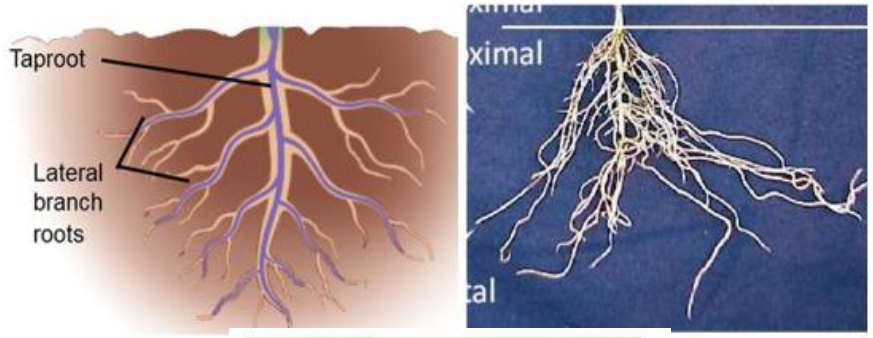
Flowering Plant Morphology



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The Root

- **Root:** an **underground** portion of Plant.



- **Types of Root:**
  - one main vertical root (Tap root) consists of lateral roots and root hairs.
  - Adventitious roots arise from stems or leaves



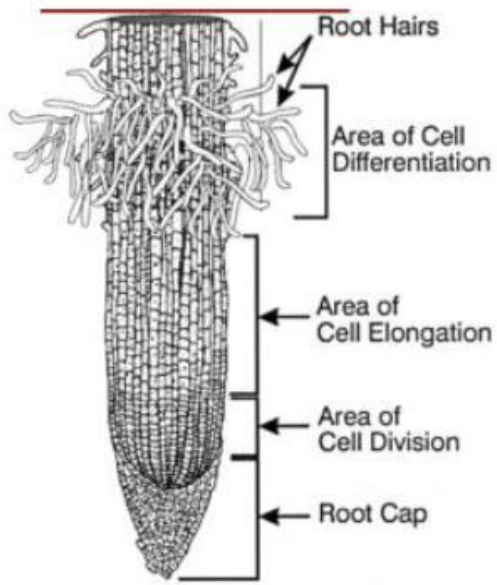
Zones of the Root - External Anatomy

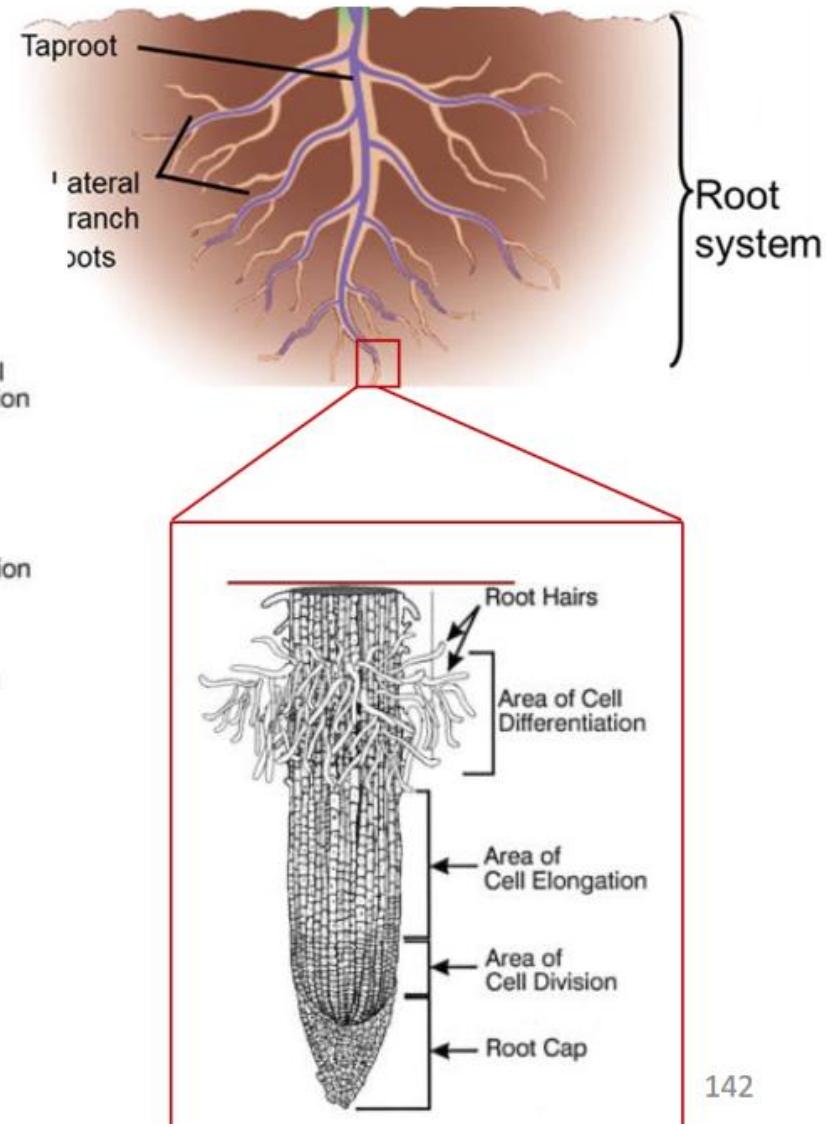
1. Meristematic zone

- Root cap
- Region of cell division

2. Elongation zone

3. Maturation (or differentiation) **zone**





Functions of the root system

1. Responsible for **anchoring** and **support** the plant in the soil.
2. Roots **absorb** water and dissolved nutrients or solutes (nitrogen, phosphorous, magnesium, boron, etc.) needed for normal growth, development, photosynthesis, and reproduction.
3. In some plants, roots have become adapted for specialized functions ex: **storage**..

Many plants have modified roots



Prop roots



Storage roots



"Strangling" aerial roots



Pneumatophores

Buttress roots

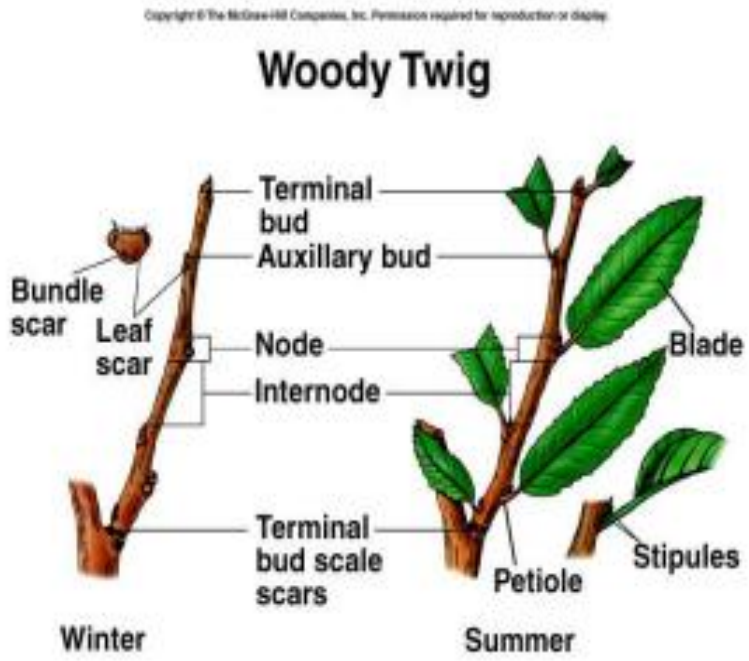


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The Stem

- **Stem**: **aboveground** portion of shoot, bearing leaves.

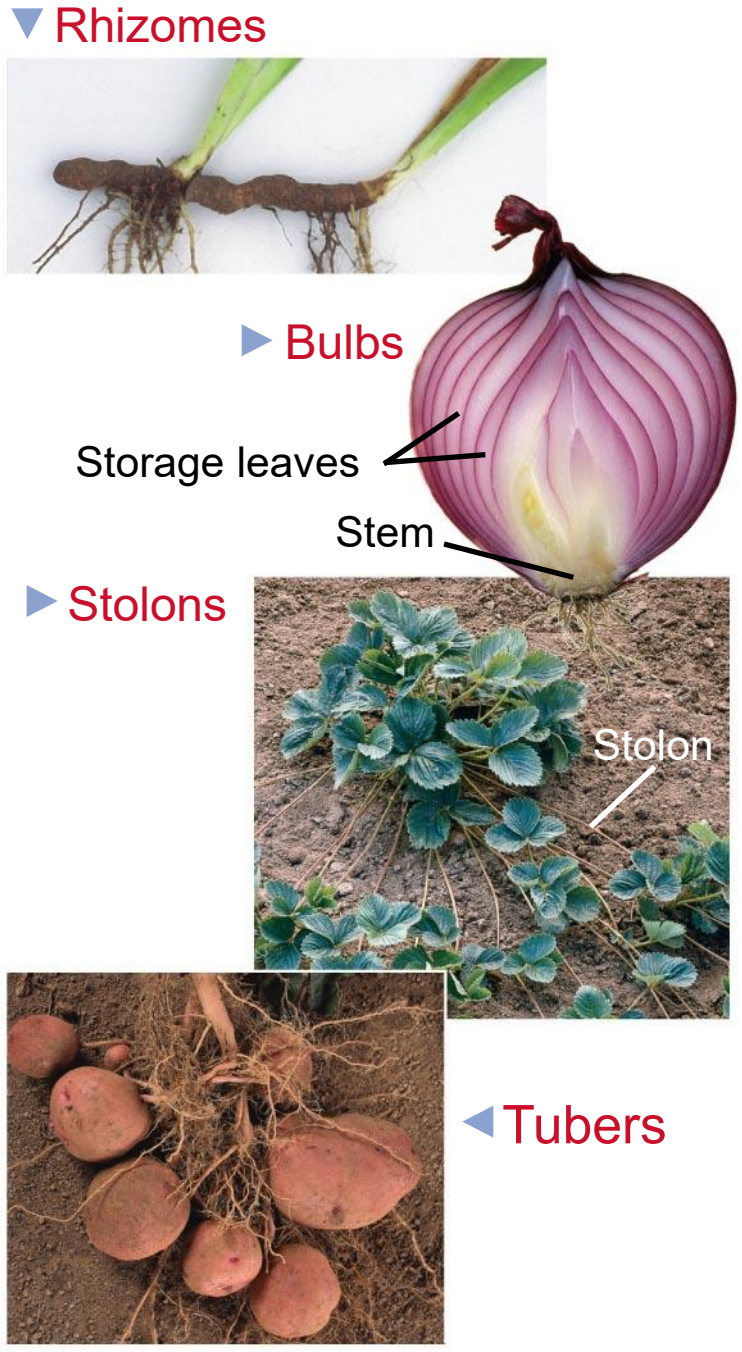
- **Divided into:**
  - Nodes (where leaves attach)
  - Internodes (where no leaves attached)



Functions of the Stem

1. **Support** of leaves, flowers, fruits
2. **Conduction** of water, minerals, sugars, etc.
3. **Photosynthesis**
4. **Storage**
5. **Defence**

Many Plants have Modified Stems



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The leaf and Leaf Functions

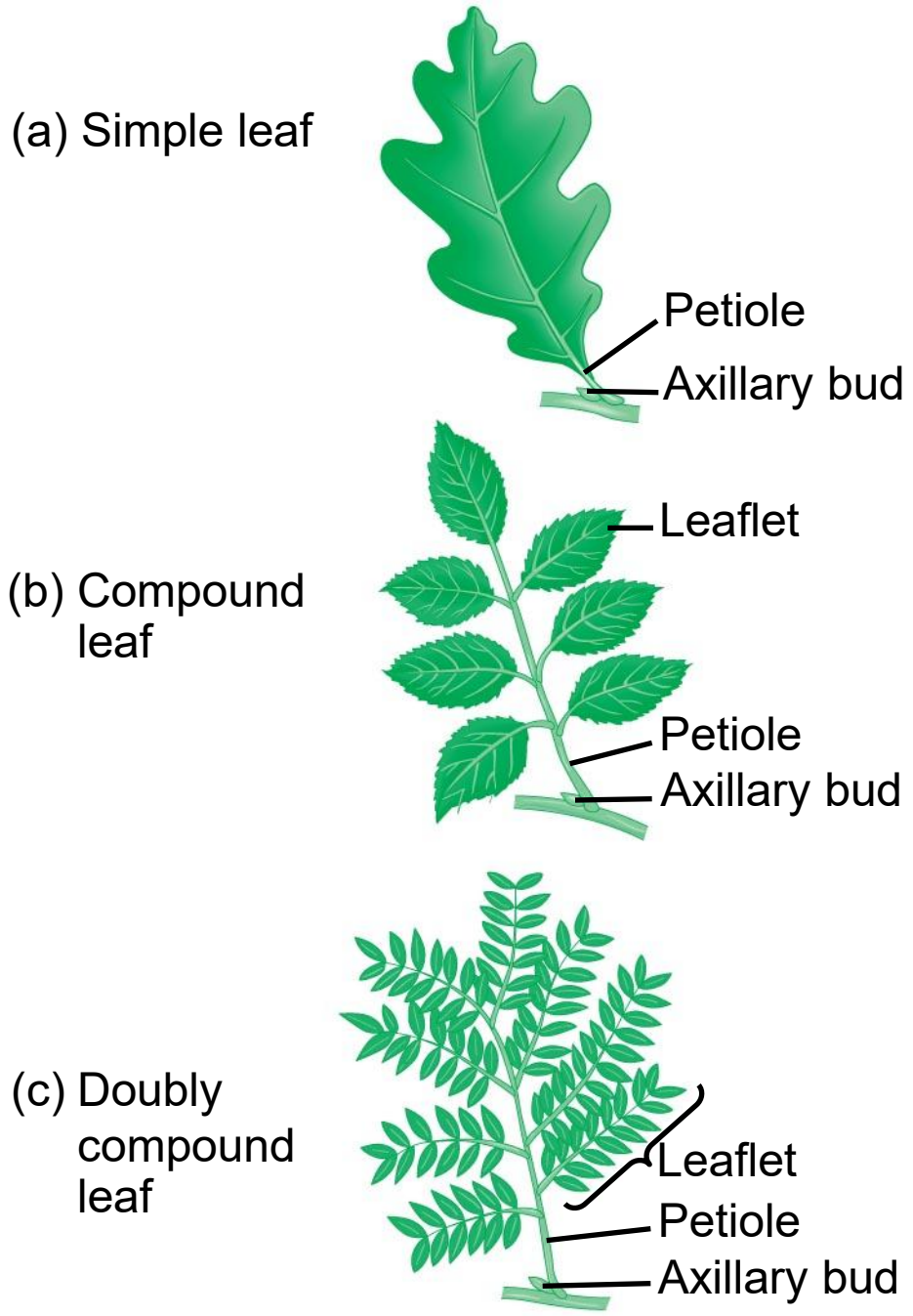
The leaf is the most important vegetative organ of the plant.

It is generally green flat body, have phototropism.

Leaf Functions:

- **Photosynthesis**
- **Gaseous Exchange**
- **Transpiration**, **Absorption** and **Reproduction**…etc

Simple vs. Compound Leaves



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Some plant species have evolved* modified leaves *that serve various functions

Tendrils
cling



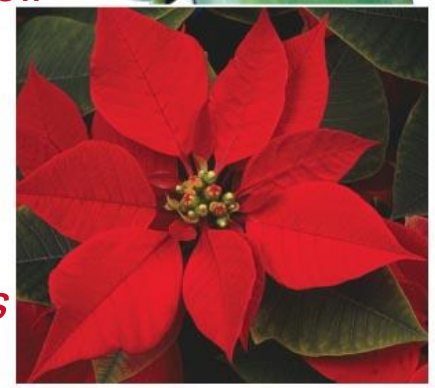


Spines *"prickly" Photosynthesis is carried out mainly by the fleshy stems*



Storage Leaves *succulent plant leaves store water*

Reproductive leaves
Little plantlets fall off and take root in the soil



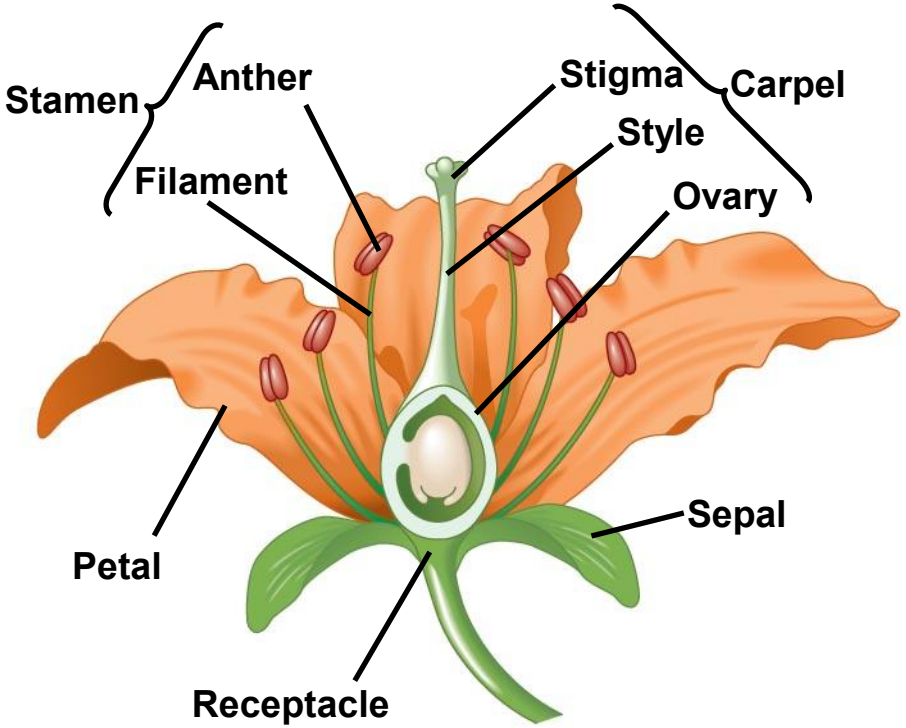
Bracts
Look like petals
Attract pollinators

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Flower Structure and Function

- **Flowers** are the reproductive shoots of the angiosperm sporophyte.
- **Flowers consist** of **four** floral organs: **sepals**, **petals**, **stamens**, and **carpels**.
- A **stamen** consists of a filament topped by an anther with pollen sacs that produce pollen.
- A **carpel** / pistil has a long style with a stigma on which pollen may land.
- At the base of the style is an ovary containing one or more ovules.

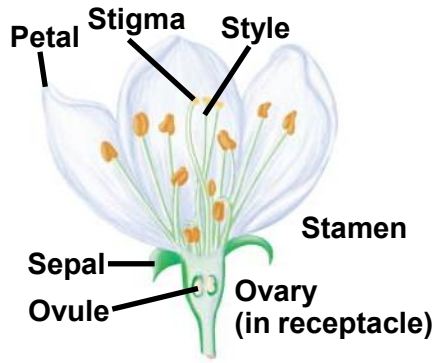
Flower Structure



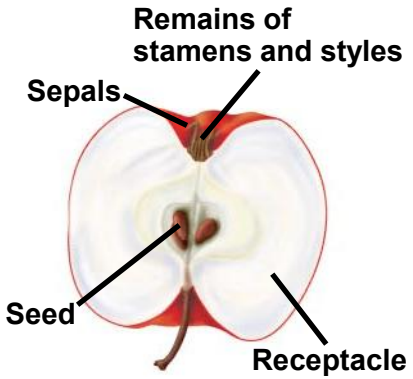
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Fruit Structure and Function

- A **fruit** develops from the ovary.
- It **protects** the enclosed **seeds** and aids in seed dispersal by wind or animals.
- A **fruit may be classified** as:
  - dry, if the ovary dries out at maturity
  - fleshy, if the ovary becomes thick, soft, and sweet at maturity.



Apple flower



Apple fruit

(d) Accessory fruit

Plant Nutrition and Soil structure

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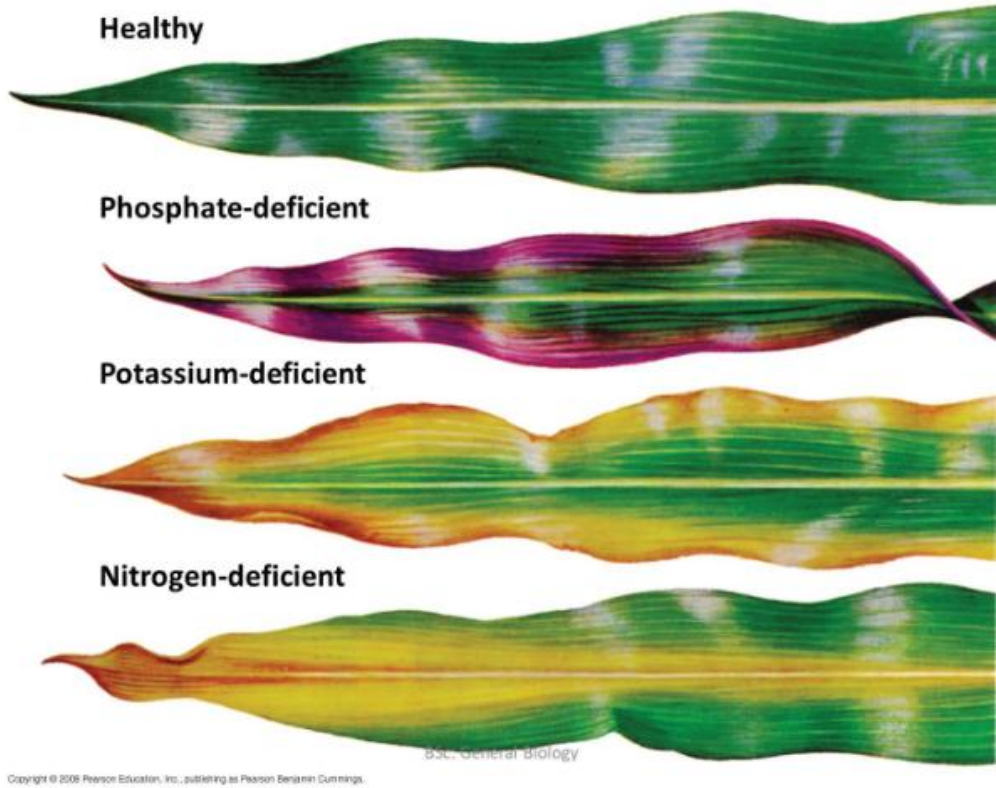
Plant Nutrition

- Plants derive most of their organic mass from the CO_2 of air, but they also depend on soil nutrients such as water and minerals.
- The inorganic substances in plants contain more than **50 chemical elements**.
- In studying the chemical composition of plants, we must distinguish elements that are **essential** from those that are **merely present** in the plant.
- A **Chemical element** is considered an **essential element** if it is **required** for a plant to complete its life cycle.

Plants require elements to complete their life cycle

- **Nine** of the **Essential elements** are called **Macronutrients** because plants **require** them in relatively large amounts.

- The **Macronutrients** are carbon, oxygen, hydrogen, nitrogen, phosphorus, sulfur, potassium, calcium, and magnesium.

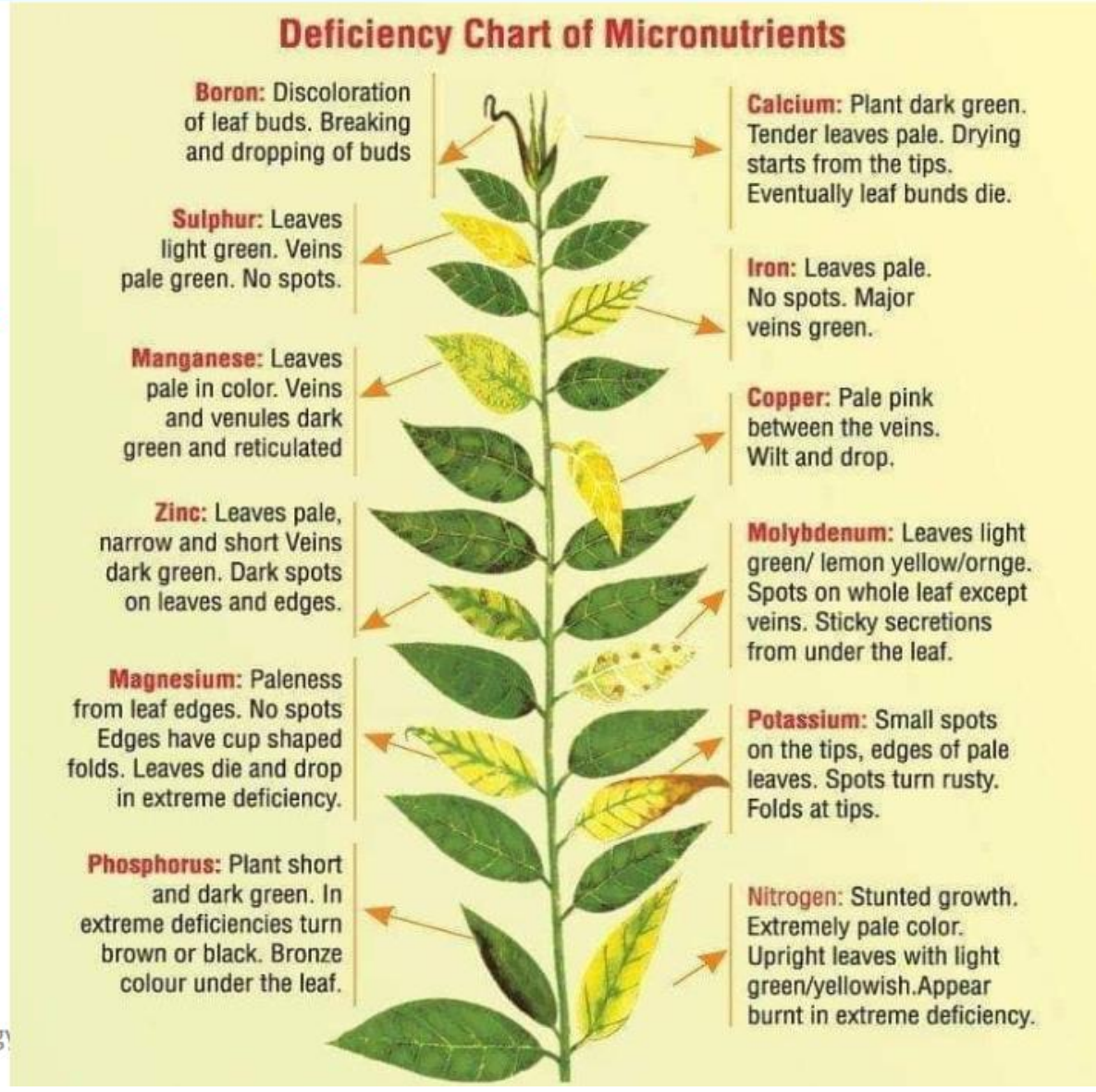


The most common mineral deficiencies, as seen in maize leaves

Plants require elements to complete their life cycle

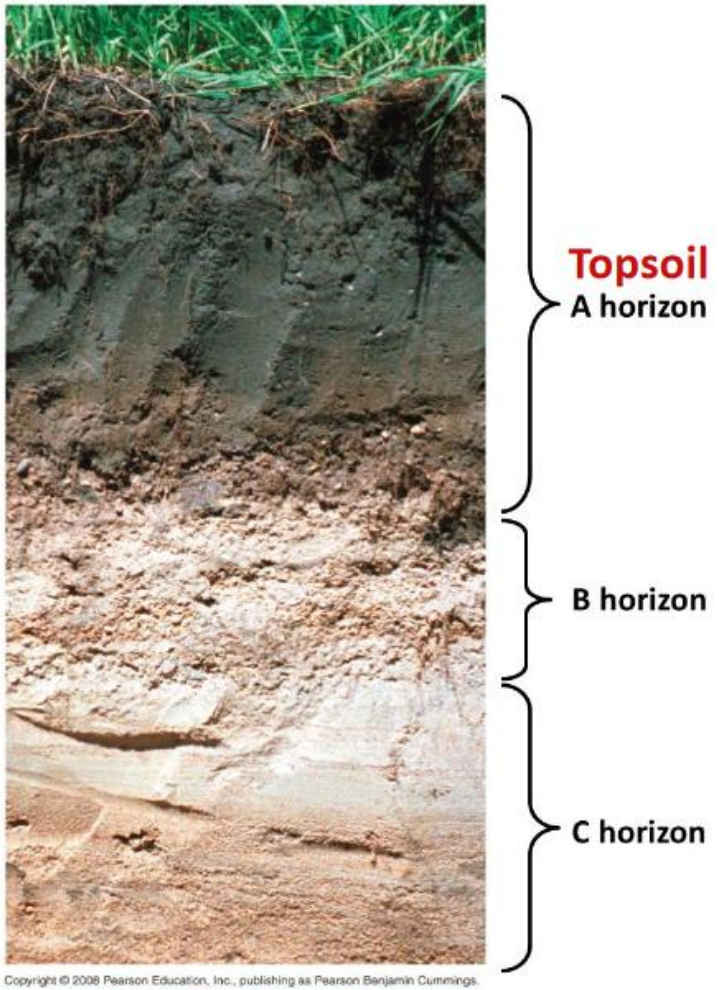
- **Eight** of the **essential elements** are called **Micronutrients** because plants need them in very small amounts.

- These are chlorine, iron, manganese, boron, zinc, copper, nickel, and molybdenum.



Soil and Soil Structure

- Healthy soils improve plant growth by enhancing plant **nutrition.**
- **Topsoil** consists of mineral particles, living organisms, and humus = the decaying organic material.
- **Soil particles** are **classified** by **size**; from largest to smallest, they are called sand, silt, and clay.
- **Soil particle size** affects the availability of water, oxygen, and minerals in the soil.



Soil horizons

Fertilization

- **Fertilization replaces** mineral nutrients that have been **lost** from the soil.
- **Commercial fertilizers** are enriched in nitrogen, phosphorus, and potassium.
- **Organic fertilizers** are composed of manure, fishmeal, or compost.



Organic fertilizers | Commercial fertilizers

Section 4

Plant Responses to Internal and External Signals

Plant hormones help coordinate growth, development, and responses to stimuli

- **Hormones** are chemical **signals** that **coordinate** different parts of an organism.
- Any response resulting in curvature of organs toward or away from a stimulus is called a **tropism** = **a growth response**.
- **Tropisms** are often caused by **hormones**.

Plant Hormones

- In general, **hormones control** plant growth and development by affecting the division, elongation, and differentiation of cells.

- **Plant hormones** are **produced** in **very low concentration**, but a minute amount can greatly affect growth and development of a plant organ.

Table 39.1 Overview of Plant Hormones

Hormone	Where Produced or Found in Plant	Major Functions
Auxin (IAA)	Shoot apical meristems and young leaves are the primary sites of auxin synthesis. Root apical meristems also produce auxin, although the root depends on the shoot for much of its auxin. Developing seeds and fruits contain high levels of auxin, but it is unclear whether it is newly synthesized or transported from maternal tissues.	Stimulates stem elongation (low concentration only); promotes the formation of lateral and adventitious roots; regulates development of fruit; enhances apical dominance; functions in phototropism and gravitropism; promotes vascular differentiation; retards leaf abscission.
Cytokinins	These are synthesized primarily in roots and transported to other organs, although there are many minor sites of production as well.	Regulate cell division in shoots and roots; modify apical dominance and promote lateral bud growth; promote movement of nutrients into sink tissues; stimulate seed germination; delay leaf senescence.
Gibberellins	Meristems of apical buds and roots, young leaves, and developing seeds are the primary sites of production.	Stimulate stem elongation, pollen development, pollen tube growth, fruit growth, and seed development and germination; regulate sex determination and the transition from juvenile to adult phases.
Brassinosteroids	These compounds are present in all plant tissues, although different intermediates predominate in different organs. Internally produced brassinosteroids act near the site of synthesis.	Promote cell expansion and cell division in shoots; promote root growth at low concentrations; inhibit root growth at high concentrations; promote xylem differentiation and inhibit phloem differentiation; promote seed germination and pollen tube elongation.
Abscisic acid (ABA)	Almost all plant cells have the ability to synthesize abscisic acid, and its presence has been detected in every major organ and living tissue; may be transported in the phloem or xylem.	Inhibits growth; promotes stomatal closure during drought stress; promotes seed dormancy and inhibits early germination; promotes leaf senescence; promotes desiccation tolerance.
Ethylene	This gaseous hormone can be produced by almost all parts of the plant. It is produced in high concentrations during senescence, leaf abscission, and the ripening of some types of fruits. Synthesis is also stimulated by wounding and stress.	Promotes ripening of many types of fruit, leaf abscission, and the triple response in seedlings (inhibition of stem elongation, promotion of lateral expansion, and horizontal growth); enhances the rate of senescence; promotes root and root hair formation; promotes flowering in the pineapple family.

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