

Chapter 13 : Plant Growth and Development

Biology Notes | Class 11

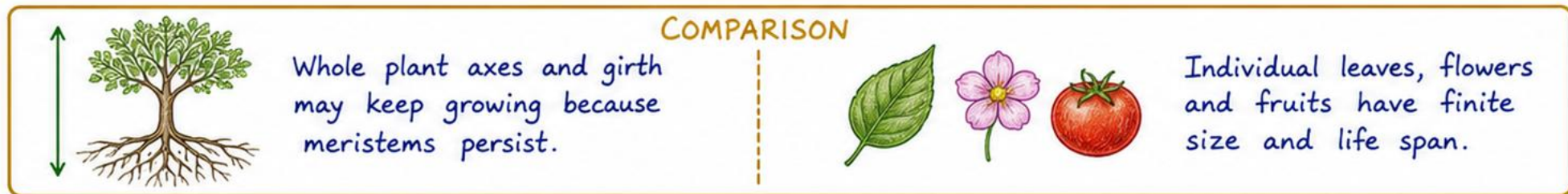
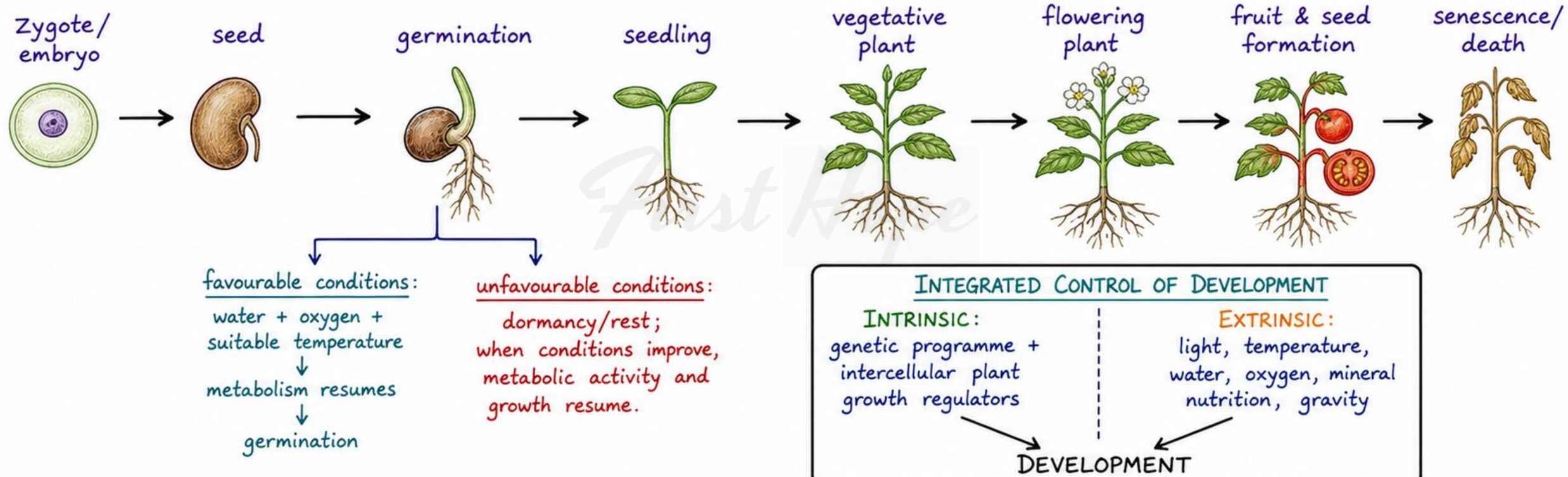


PLANT GROWTH & DEVELOPMENT: LIFE-CYCLE FRAMEWORK

GROWTH: an irreversible permanent increase in size of a cell, organ, plant part or whole plant, usually supported by metabolism and energy.

DIFFERENTIATION: acquisition of specialised structure and function.

DEVELOPMENT: the ordered changes across the life cycle; broadly $\text{DEVELOPMENT} = \text{GROWTH} + \text{DIFFERENTIATION}$.



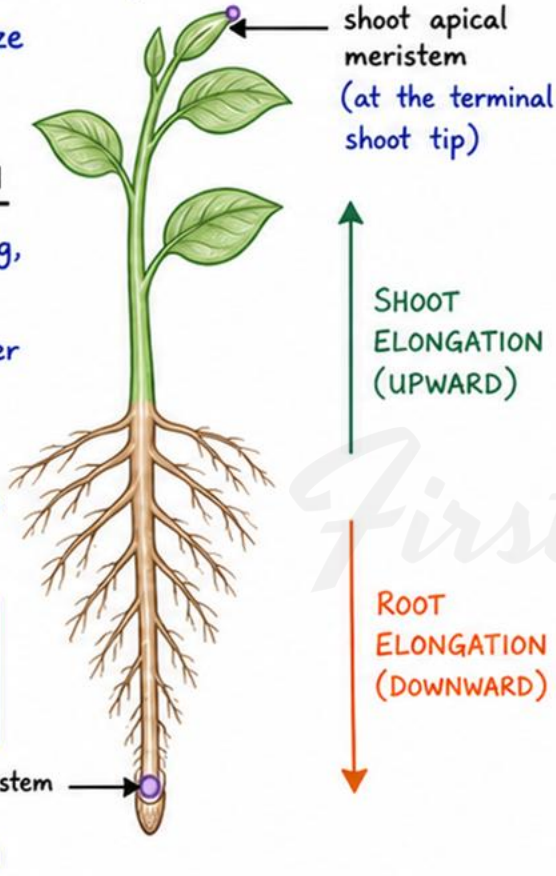
OPEN GROWTH & PLANT MERISTEMS

PLANT GROWTH is the irreversible, permanent, metabolically supported increase in size (length, area, volume and/or mass).

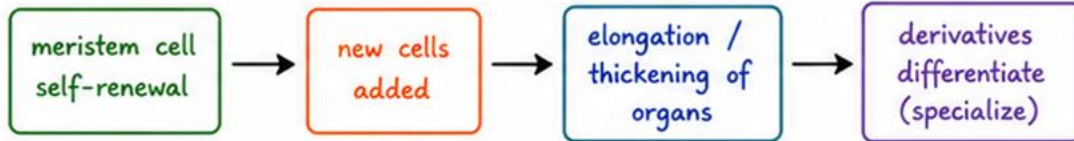
OPEN / USUALLY INDETERMINATE GROWTH

- Persistent meristems contain self-renewing, actively dividing cells.
- These cells continuously add new daughter cells to the growing regions.
- Most derivatives later lose the capacity to divide and differentiate to form tissues and organs.

Qualification: An individual organ or meristem may be determinate (limited by its fate) or may stop activity.



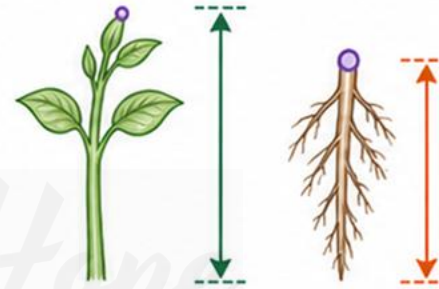
CAUSE → EFFECT FLOW OF OPEN GROWTH



★ **ACCURACY NOTE:** Swelling of dead wood in water is **IMBIBITION**, not biological growth, because it is not metabolically driven and is reversible.

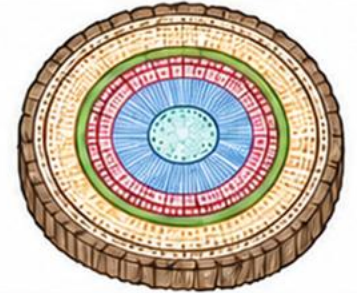
PRIMARY GROWTH

- Increase in length along the axis.
- Brought about by root apical meristem and shoot apical meristem.

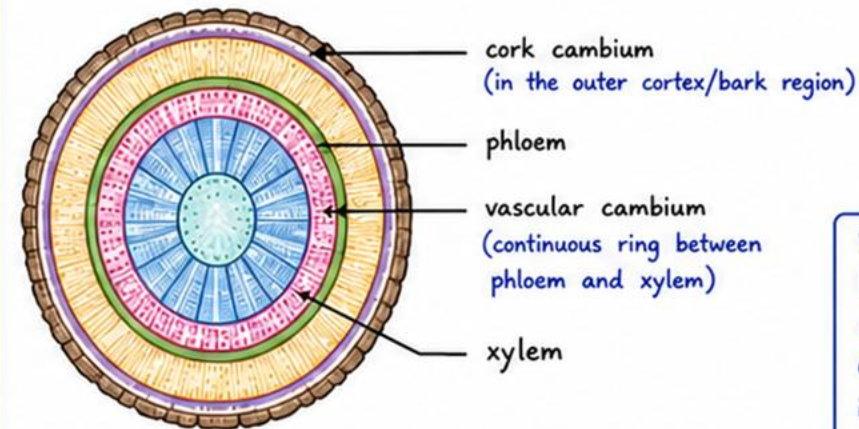


SECONDARY GROWTH

- Increase in girth (thickness).
- Common in dicots and gymnosperms.
- Vascular cambium and cork cambium become active later.



STEM CROSS-SECTION (DICOT) SHOWING SECONDARY GROWTH

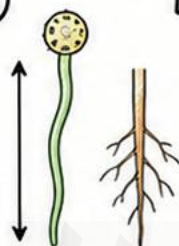
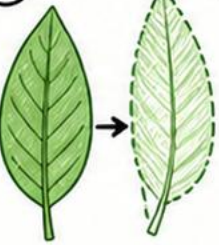
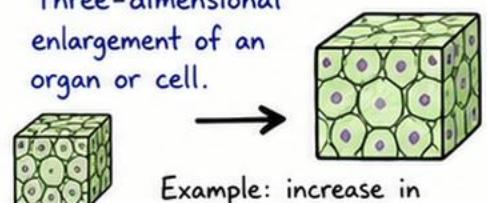
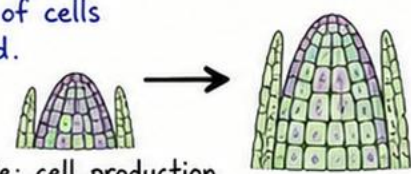


- xylem
- phloem
- vascular cambium
- cork cambium

Vascular cambium lies between xylem (inside) and phloem (outside). Cork cambium is outside in the cortex/bark region.

HOW PLANT GROWTH IS MEASURED

At the cellular level, growth mainly reflects an increase in protoplasm. Because protoplasm increase is difficult to measure directly, biologists measure quantities approximately proportional to growth.

① FRESH MASS  Includes variable tissue water; useful but hydration-sensitive. Example: mass of a hydratable leaf.	② DRY MASS  Accumulated material after water removal; often better for biomass. Example: dry mass of a shoot.	③ LENGTH  Linear extension along an axis. Example: pollen-tube extension or root elongation.
④ AREA  Two-dimensional expansion of a surface. Example: expansion of a dorsiventral leaf surface.	⑤ VOLUME  Three-dimensional enlargement of an organ or cell. Example: increase in volume of a fruit or storage organ.	⑥ CELL NUMBER  Increase in the number of cells produced. Example: cell production in a shoot apical meristem.

DATA & SCALE

- One maize root apical meristem can produce **MORE THAN 17,500 NEW CELLS PER HOUR**.
- A watermelon cell may increase in size by **UP TO ABOUT 350,000-FOLD**.
- Pollen-tube growth is commonly followed by **LENGTH**.
- Growth of a dorsiventral leaf is commonly followed by **SURFACE AREA**.

STRUCTURE
(organ, tissue, cell type)

+

STAGE
(developmental stage)

+

QUESTION
(what aspect of growth?)



choose the appropriate growth parameter.

KEY (not interchangeable)

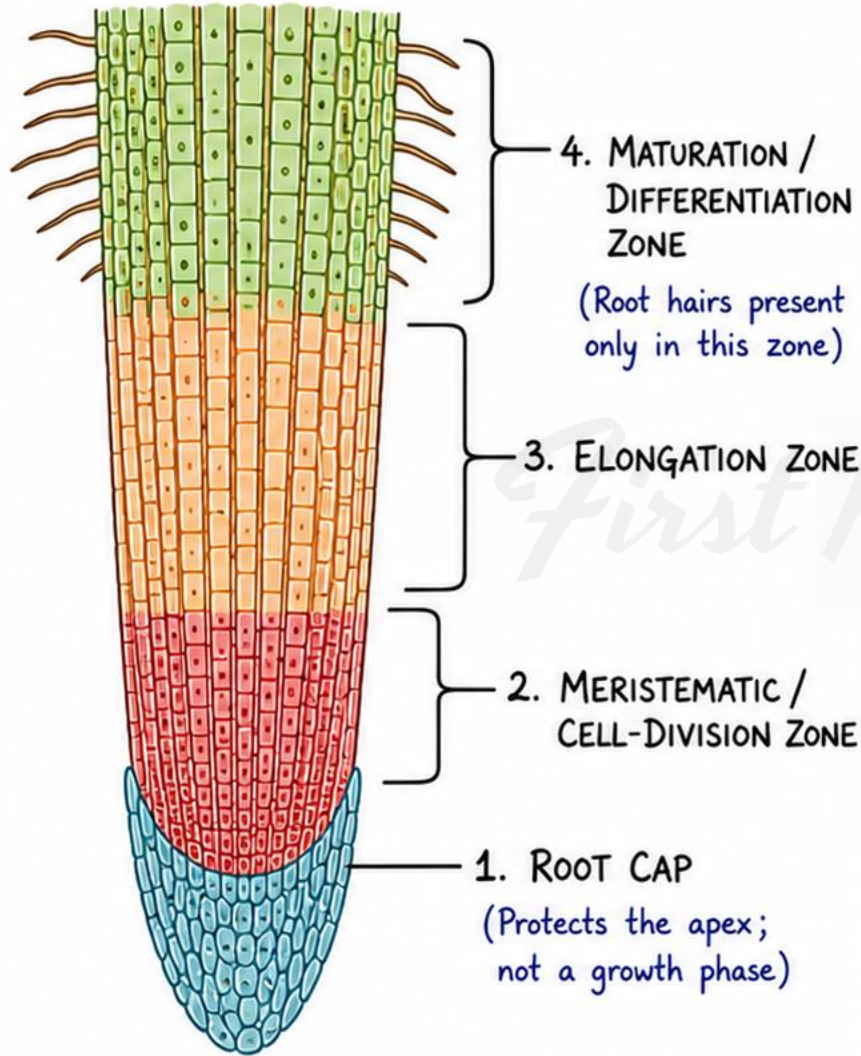
- Cell size (e.g., volume, area, length, mass)
- Cell number (count of cells)
- Rate (change per unit time)
- Amount (total at a given time)

No single parameter demonstrates every kind of plant growth throughout the life cycle.

PHASES OF GROWTH AT A ROOT TIP

LONGITUDINAL SECTION OF A YOUNG ROOT TIP

Direction of
growth
(away from
the apex)



COLOUR LEGEND

- Maturation / Differentiation Zone
- Elongation Zone
- Meristematic / Cell-Division Zone
- Root Cap

THE THREE PHASES OF GROWTH

1. MERISTEMATIC PHASE

- Actively dividing, small cells.
- Dense/rich protoplasm.
- Large conspicuous nuclei.
- Thin primary cellulosic walls.
- Many plasmodesmatal connections.

2. ELONGATION PHASE

- Increased vacuolation.
- Rapid cell enlargement/extension.
- New cell-wall deposition.

3. MATURATION PHASE

- Cells attain maximal size for their fate.
- Wall thickening and protoplasmic specialisation.
- Permanent tissues and root hairs differentiate.

PRINCIPLE

Growth zones are spatially continuous and cells pass through them as they are displaced away from the apex.

SEQUENCE OF CELLULAR CHANGES

cell division
↓
cell elongation
↓
maturation/
differentiation

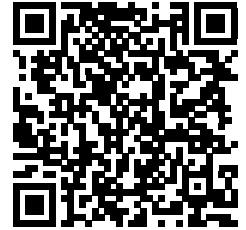


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