

- **Unit 1: Plant growth and Movement** (06 Lectures)
 - Plant growth: Introduction and Definition
 - Phases of growth
 - Growth curve
 - Factors affecting growth
 - Plant movement: Introduction and Definition
 - Types of plant movement: i) Tropic ii) Tactic iii) Nastic

1.1 Plant Growth: Introduction and Definition

- **Growth** is one of the important characteristics of living organisms.
- In plants, growth is generally **continuous** throughout life due to the presence of **meristematic tissues**.
- Growth involves:
 - Increase in **size**
 - Increase in **length**
 - Increase in **volume**
 - Increase in **dry weight**
 - Increase in **cell number**
- Growth occurs mainly due to:
 - **Cell division**
 - **Cell enlargement**
 - **Cell differentiation**
- **Definition:** Growth is an **irreversible increase in the size, volume, mass or dry weight of a living organism or its parts**.
- Plant growth is mainly localized in **meristematic regions**, such as:
 - Root apical meristem
 - Shoot apical meristem
 - Intercalary meristem
 - Lateral meristem

1.2 Phases of Growth

Plant growth occurs in **three main phases**:

A. Meristematic Phase

- Occurs in regions containing actively dividing cells.
- Cells undergo **rapid mitotic division**.
- Characteristics:
 - Small cells

- Thin cell walls
- Dense cytoplasm
- Large nucleus
- Prominent proplastids
- Little or no vacuolation
- Examples:
 - Root tip
 - Shoot tip

B. Elongation Phase

- Cells produced by the meristematic region undergo **rapid enlargement**.
- Main features:
 - Increase in cell size
 - Development of vacuoles
 - Cell wall stretching
 - Increased water absorption
 - Increased synthesis of proteins and cell-wall materials
- This phase contributes greatly to **increase in length** of roots and shoots.

C. Maturation Phase

- Cells attain their **maximum size**.
- Cells become specialized and acquire specific functions.
- This process is called **differentiation**.
- Examples:
 - Xylem cells
 - Phloem cells
 - Epidermal cells
 - Parenchyma cells

Sequence:

Meristematic phase → Elongation phase → Maturation phase

1.3 Growth Curve

- Growth can be represented graphically by plotting **growth against time**.
- The typical growth curve of a plant is **sigmoid (S-shaped)**.
- It consists of different phases:

1. Lag Phase

- Initial phase of growth.
- Growth is **slow**.
- Cells prepare for active growth.
- Metabolic activity gradually increases.

2. Log/Exponential Phase

- Growth becomes **rapid and maximum**.
- Cells divide and enlarge rapidly.
- Growth rate remains nearly constant at its maximum.
- This is the most active phase of growth.

3. Deceleration Phase

- Growth rate gradually decreases.
- Cells approach their maximum size.
- Nutrients and other resources may become limiting.

4. Stationary Phase

- Growth becomes **very slow or stops**.
- Cells reach their maximum size.
- The plant or organ approaches maturity.

Sigmoid Growth Curve

Lag → Log/Exponential → Deceleration → Stationary

1.4 Factors Affecting Plant Growth

Plant growth is affected by **internal and external factors**.

A. Internal Factors

1. Genetic Factors

- Genes control the growth pattern of plants.
- Different plant species have different growth rates and sizes.

2. Plant Hormones/Growth Regulators

Important growth regulators include:

- **Auxins**
 - Promote cell elongation
 - Help in root initiation
 - Control tropic responses
- **Gibberellins**
 - Promote stem elongation
 - Break seed dormancy
 - Promote seed germination
- **Cytokinins**
 - Promote cell division
 - Delay leaf senescence

- **Ethylene**
 - Promotes fruit ripening
 - Influences leaf and fruit abscission
- **Abscisic acid (ABA)**
 - Promotes seed dormancy
 - Helps plants respond to water stress
 - Generally acts as a growth inhibitor.

B. External Factors

1. Water

- Essential for:
 - Cell expansion
 - Photosynthesis
 - Transport of nutrients
 - Maintenance of turgidity
- Lack of water causes **wilting and reduced growth**.

2. Temperature

- Each plant has a minimum, optimum and maximum temperature for growth.
- Very low or very high temperatures reduce growth.
- Optimum temperature promotes maximum growth.

3. Light

- Required for photosynthesis.
- Influences:
 - Stem growth
 - Leaf development
 - Flowering
 - Phototropism
- Insufficient light may cause **etiolation**.

4. Oxygen

- Required for **respiration**.
- Respiration provides energy needed for growth.
- Poor oxygen supply reduces root growth.

5. Mineral Nutrients

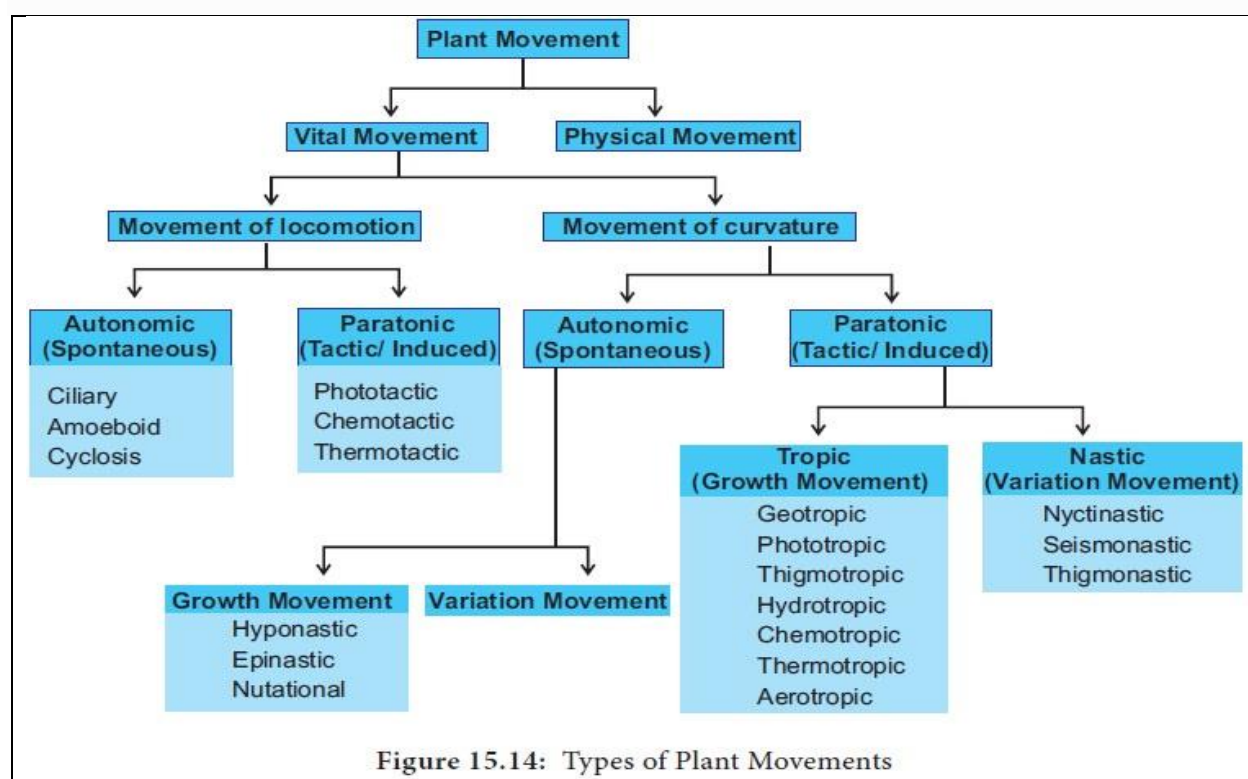
- Essential elements such as **N, P, K, Ca, Mg, S and micronutrients** are required.
- Nitrogen is particularly important for:

- Protein synthesis
- Chlorophyll formation
- Vegetative growth
- Deficiency of nutrients results in abnormal growth.

6. Carbon Dioxide

- Required for **photosynthesis**.
- Adequate CO₂ supports carbohydrate production and growth.

1.5 Plant Movement: Introduction and Definition



- Plants appear stationary, but different parts of plants can show **movement**.
- Plant movements occur in response to:
 - Light
 - Gravity
 - Water
 - Chemicals
 - Temperature
 - Touch
- Movements may involve:
 - Growth of plant organs

- Changes in cell turgor
- Movement of the whole organism

Definition

Plant movement is the change in position or orientation of a plant or its part in response to internal or external stimuli.

Importance of Plant Movement

- Helps plants obtain **light**.
- Helps roots grow towards **water and minerals**.
- Helps plants respond to environmental conditions.
- Assists in **reproduction and survival**.

1.6 Types of Plant Movement

Plant movements are broadly classified into:

1. **Tropic movements**
2. **Tactic movements**
3. **Nastic movements**

I. Tropic Movement

- A **directional growth movement** of a plant part in response to an external stimulus.
- Direction of movement depends on the **direction of the stimulus**.
- Usually caused by **unequal growth** on two sides of an organ.

Types

A. Phototropism

- Movement in response to **light**.
- **Positive phototropism:** movement towards light.
 - Example: Shoot bends towards light.
- **Negative phototropism:** movement away from light.
 - Example: Roots generally show negative phototropism.

B. Geotropism/Gravitropism

- Movement in response to **gravity**.
- Roots → **positive geotropism**
- Shoots → **negative geotropism**

C. Hydrotropism

- Movement in response to **water**.

- Roots generally show **positive hydrotropism**.
- Example: Roots grow towards a source of water.

D. Chemotropism

- Movement in response to **chemicals**.
- Example: Growth of pollen tube towards the ovule due to chemical signals.

E. Thigmotropism

- Movement in response to **touch/contact**.
- Example: Coiling of tendrils around a support.

II. Tactic Movement

- **Tactic movement** is the directional movement of a **whole motile cell or organism** in response to an external stimulus.
- It is commonly observed in **motile organisms or reproductive cells**.
- The direction of movement depends on the direction of the stimulus.

Types

- **Phototaxis:** movement in response to light.
- **Chemotaxis:** movement in response to chemicals.
- **Geotaxis:** movement in response to gravity.

Example

- Movement of motile algae such as **Chlamydomonas** towards light.

III. Nastic Movement

- **Nastic movement** is a non-directional movement of a plant part in response to an external stimulus.
- Direction of movement **does not depend on the direction of the stimulus**.
- Often caused by changes in **cell turgor** or differential growth.

Types and Examples

A. Photonasty

- Movement in response to light.
- Example: Opening and closing of some flowers in response to light intensity.

B. Thermonasty

- Movement in response to temperature.
- Example: Opening of certain flowers with an increase in temperature.

C. Thigmonasty/Seismonasty

- Movement in response to touch or mechanical stimulus.
- Example: Folding of leaves of **Mimosa pudica** when touched.

Quick Comparison

Feature	Tropic	Tactic	Nastic
Nature	Directional	Directional	Non-directional
Organism/part	Plant organ	Whole motile cell/organism	Plant organ/part
Direction depends on stimulus	Yes	Yes	No
Main mechanism	Growth	Locomotion	Growth or turgor change
Example	Shoot bending towards light	Chlamydomonas moving towards light	Mimosa leaf folding

Important Definitions for Exam

- **Growth:** Irreversible increase in size, volume, mass or dry weight.
- **Growth curve:** Graphical representation of growth with respect to time; commonly S-shaped.
- **Tropism:** Directional growth movement in response to a stimulus.
- **Taxis:** Directional movement of a whole motile cell or organism in response to a stimulus.
- **Nastic movement:** Non-directional movement of a plant part in response to a stimulus.