

Control & Coordination



Lecture Notes on Control and Coordination in Plants

Plant Movements

Plants exhibit movements in response to various environmental stimuli. These movements can be classified into tropic movements and nastic movements.

Tropic Movements

Tropic movements are directional growth responses in which the direction of the stimulus determines the direction of the movement. The main types of tropic movements are:

- **Phototropism:** Growth response to light. Shoots typically exhibit positive phototropism (grow towards light), while roots may show negative phototropism (grow away from light).
- **Geotropism (Gravitropism):** Growth response to gravity. Roots exhibit positive geotropism (grow downward, towards gravity), while shoots exhibit negative geotropism (grow upward, away from gravity).
- **Hydrotropism:** Growth response to water. Roots exhibit positive hydrotropism, growing towards moisture.
- **Chemotropism:** Growth response to chemicals. For example, the growth of pollen tubes towards ovules is guided by chemical signals.

Nastic Movements

Nastic movements are non-directional responses to stimuli, independent of the direction of the stimulus. These movements are typically rapid and reversible.

- **Thigmonasty:** Movement in response to touch or mechanical stimuli. For example, the rapid closure of Venus flytrap leaves when prey touches them.
- **Seismonasty:** Movement in response to vibration. For instance, the folding of Mimosa pudica leaves when they are shaken or disturbed.

Plant Hormones

Plant hormones, or phytohormones, are chemical substances that regulate various physiological processes and coordinate growth, development, and responses to stimuli.

Types of Plant Hormones

- **Auxins:** Promote cell elongation, root initiation, and are involved in phototropism and geotropism. Auxins also play a role in the differentiation of vascular tissues.

- **Gibberellins:** Promote stem elongation, seed germination, and flowering. Gibberellins also help break seed dormancy and stimulate enzyme production in germinating seeds.
- **Cytokinins:** Promote cell division and delay leaf senescence. They work in conjunction with auxins to control cell differentiation and apical dominance.
- **Absciscic Acid (ABA):** Inhibits growth and promotes seed dormancy. ABA helps plants respond to stress conditions such as drought by closing stomata to reduce water loss.
- **Ethylene:** Promotes fruit ripening, leaf abscission, and flower wilting. Ethylene also plays a role in response to mechanical stress and pathogen attack.

Role of Hormones in Plant Growth and Development

- **Auxins:** Regulate the elongation of cells in shoots and roots, control the pattern of growth by influencing cell division and differentiation, and mediate responses to light and gravity.
- **Gibberellins:** Influence various developmental processes including seed germination, stem growth, flowering, and fruit development. They counteract some of the inhibitory effects of ABA.
- **Cytokinins:** Promote cell division and influence nutrient mobilization, leaf expansion, and the delay of senescence. They interact with auxins to balance root and shoot growth.
- **Absciscic Acid:** Acts as a growth inhibitor and plays a crucial role in seed dormancy, ensuring seeds germinate under favorable conditions. ABA also mediates plant responses to environmental stress.
- **Ethylene:** Involved in the regulation of fruit ripening, leaf abscission, and flower senescence. Ethylene helps plants respond to mechanical stress and pathogen attack by modulating growth and defense mechanisms.

Mechanisms of Hormone Action in Plants

- **Receptor Binding:** Plant hormones exert their effects by binding to specific receptors located on the cell surface or within the cell. This binding triggers a signal transduction pathway.
- **Signal Transduction:** The hormone-receptor complex initiates a cascade of biochemical reactions within the cell, often involving second messengers like calcium ions or cyclic AMP (cAMP).
- **Gene Expression:** Many plant hormones influence gene expression by activating or repressing specific genes, leading to changes in protein synthesis that affect growth and development.
- **Enzyme Activation:** Hormones can activate or inhibit enzymes that regulate metabolic pathways, leading to changes in the physiological state of the plant.

Summary

Understanding control and coordination in plants involves studying plant movements (tropic and nastic), the roles and types of plant hormones, and the mechanisms through which these hormones exert their effects. This knowledge is essential for comprehending how plants grow, develop, and respond to their environment.