



# Plant Growth Regulators


**Dr. Mahesha H B**  
**Professor and Head**  
**Department of Sericulture**  
**Yuvaraja's College**  
**University of Mysore, Mysuru, India**

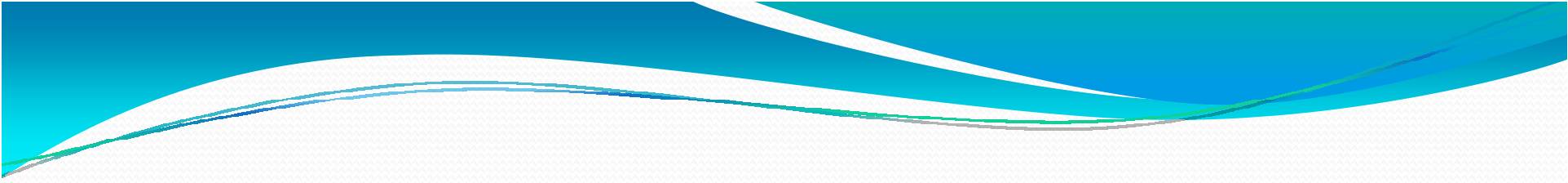
## **GROWTH**

- **Irreversible change in Mass, *i.e.* increase in size, volume and weight of any part of plant's body.**
- **It means quantitative increase in plant body.**  
***e.g.*, Cell Division, Cell Enlargement.**

## **Development**

- **Irreversible change in state.**
- **It means the qualitative change in plant body.**  
***e.g.* Seed → Seedling → Vegetative → Maturation  
→ Flowering**

- 
- **Plant's growth and development :- Under the control of two sets of internal factors.**
  - **Nutritional factors:- carbohydrates, proteins, fats and others constitute the raw materials required for growth.**
  - **Proper utilization of these raw materials is under the control of certain “chemical messengers” which can be classified into hormones and vitamins.**

- 
- **The term Hormone is derived from a Greek root '*hormao*' which means 'to stimulate' (Beylis and Starling, 1902).**
  - **Thimann (1948) suggested using the term 'Phytohormone' for Hormones of plant.**

- 
- **Phytohormones are organic substances produced naturally by the plants which in minute/low concentration**

**increase,**

**decrease**

**modify the growth and development.**

- ***Also termed as***

**growth hormones**

**growth promoting substances**

**growth substances**

**growth regulators**

**growth factors etc.**

## **Plant Growth Regulators**

- **Plant Growth regulators (PGR) refers to natural or synthetic substances influence the growth and development.**
- **IAA (Auxin)- Both natural and synthetic.**
- **IBA (Auxin) - Always synthetic.**
- **All plant hormone are plant growth regulators but,**

**All plant growth regulator are not plant hormones**

# Classification of PGR

## *On the Basis of Origin*

- **Natural hormone: Produced by some tissues in the plant. Also called Endogenous hormones. e.g. IAA.**
- **Synthetic hormone: Produced artificially and similar to natural hormone in physiological activity. Also called Exogenous hormones. e.g. 2,4- D, NAA etc.**
- **Postulated hormone: Also produced spontaneously in the plant body, but their structure and function is not discovered clearly. e.g. Vernalin.**

# Classification of PGR

## *On the Basis of Nature of Function*

- **Growth promoting hormones/Growth promoter:**  
**Increase the growth of plant.**  
***e.g., Auxins. Gibberellins, Cytokinins etc.***
- **Growth inhibiting hormones/Growth retardant:**  
**Inhibit the growth of plant.**  
***e.g., ABA, Ethylene.***

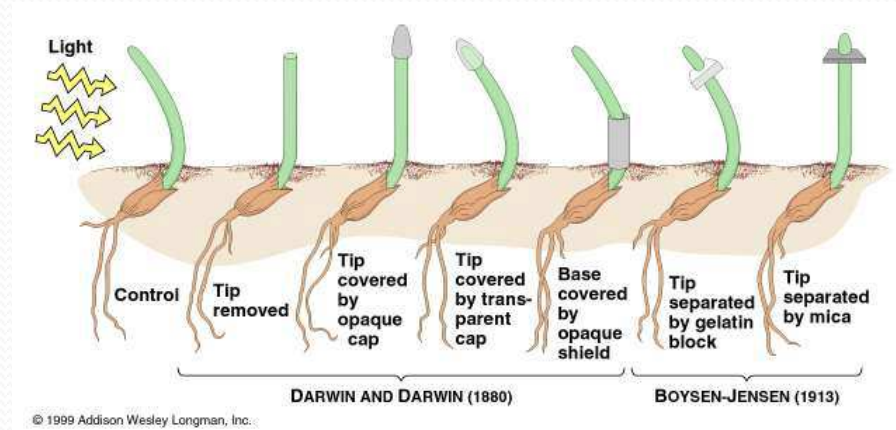




# AUXINS

- **Derived from the Greek word "auxein" means- "to grow/increase".**
- **Auxins may be defined as growth promoting substances which promote growth along the vertical axis when applied in low concentration to the shoot of the plant.**

# Discovery of Auxins



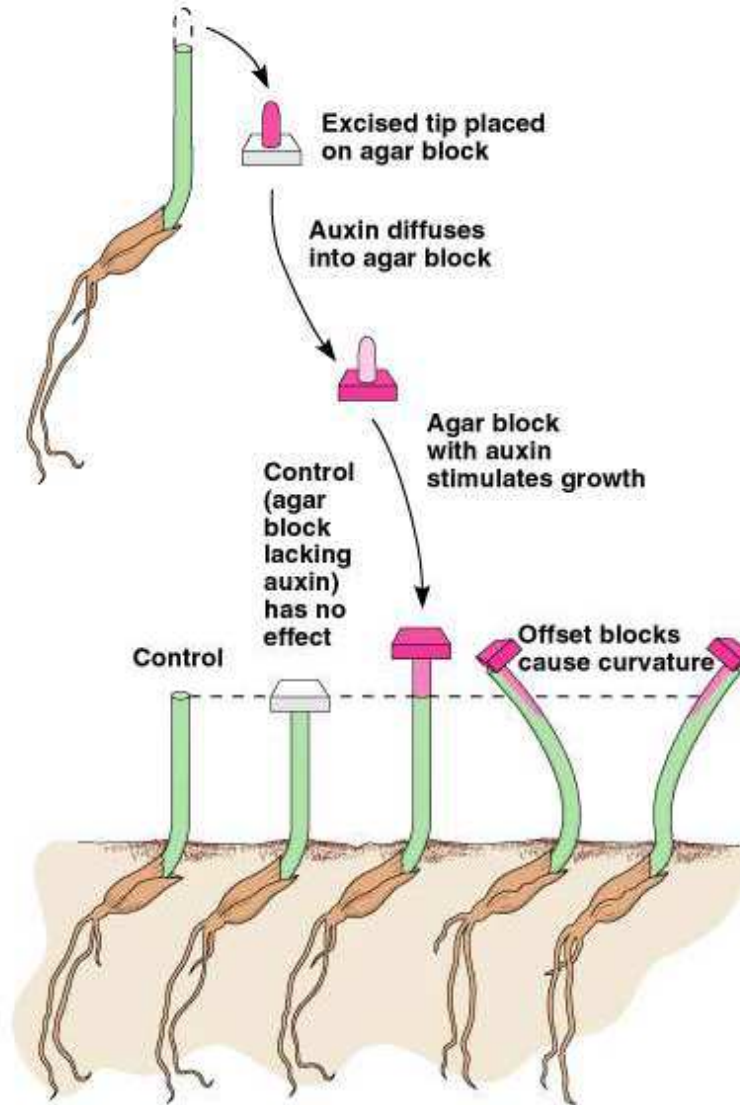
**The idea of existence of auxin was proposed by Charles Darwin (1880) in his book “The Power of Movements in Plants”.**

**Coleoptiles of Canary grass (*Phalaris canariensis*) to unilateral light and observed it to bend towards light.**

**He covered the coleoptiles tip with tin foil or cut it off and observed that coleoptiles did not bend towards unilateral light.**

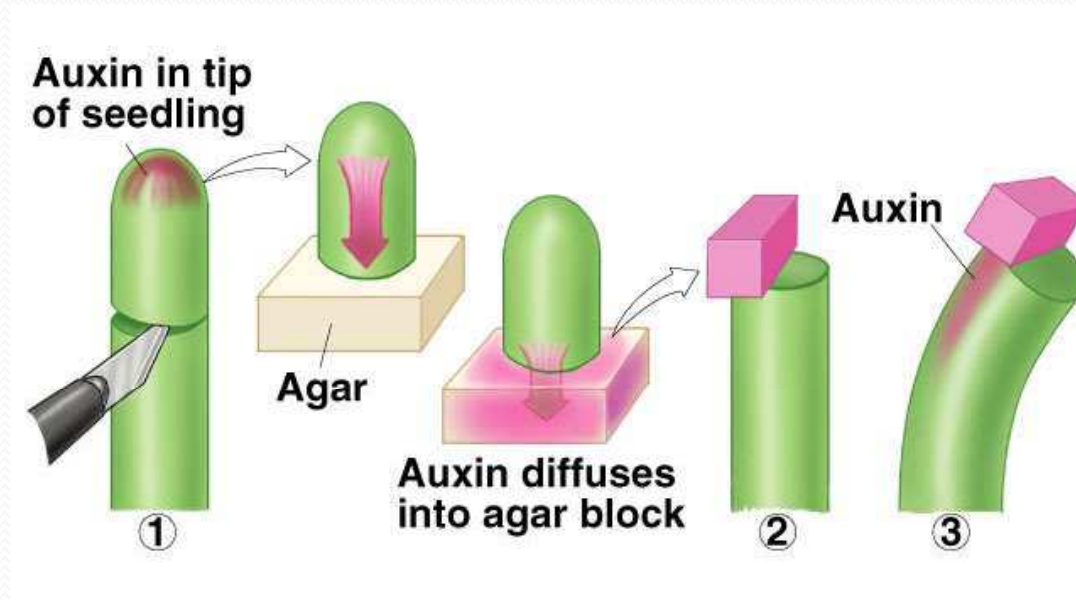
**Concluded - some stimulus is transmitted from upper to the lower part which induced bending of the coleoptiles.**

# Discovery of Auxins



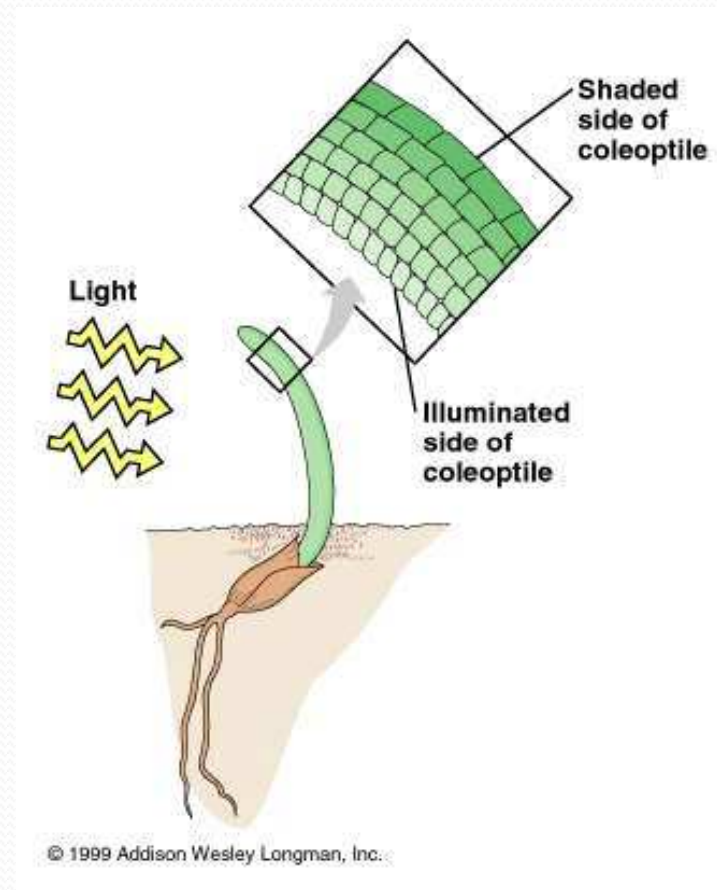
© 1999 Addison Wesley Longman, Inc.

## Discovery of Auxins



**Arpad Paál (1919) - Asymmetrical placement of cut tips on coleoptiles resulted in a bending of the coleoptile away from the side onto which the tips were placed**

# Discovery of Auxins



## Discovery of Auxins

- **F.W. Went (1926) successfully discovered and isolated this growth substance from *Avena sativa* (Oat) coleoptiles tips.**
- **Kogl and Haagen-Smit (1931) named it as “auxin”.**

## **Occurrence and Distribution of Auxins**

- **Occurs universally in all plant parts.**
- **Where there is active growth there is auxin production.**
- **Growing meristem and enlarging organs produces auxin.**
- **Shoot apex produces much auxin than root apex.**
- **Apical bud synthesizes more auxin than lateral buds.**
- **Developing seeds contain more auxin than matured seeds.**
- **Apical bud synthesizes six times more auxin than expanding leaves.**



## **Auxin Translocation**

- **Auxin transported basipetally**
- **It moves from apical to basal end**
- **Velocity of transport is- 1 to 1.5 cm/hr in stem & coleoptiles 0.1 to 0.2 cm/hr in root**



## **Auxins**

- **Synthetic Auxins—produced artificially and similar to natural in their physiological activity.**

- **IPA (Indole Propionic Acid)**
- **IBA (Indole Butyric Acid)**
- **NAA (Naphthalene Acetic Acid)**
- **2,4-D (2,4 – Dichlorophenoxy acetic acid)**
- **2,4,5-T (2,4,5 – Trichlorophenoxy acetic acid) etc.**



## **Effects of Auxin on Plant Growth & development**

### **1. Cell Elongation and Cell Division**

**The main causes of cell elongation-**

- By increasing the osmotic content, permeability of cell to water, wall synthesis.**
- By reducing wall pressure.**
- By inducing the synthesis of RNA & protein which in turn lead to an increase in cell wall plasticity & extension.**
- Auxin also induces / promotes cell division within the cambial region.**

# Effects of different Auxin on Plant Growth & development

## Apical Dominance

- Apical or terminal buds of many vascular plants are very active while the lateral buds remain inactive.
- Removal of apical buds promotes lateral buds to grow.
- Apical dominance is due to much higher auxin content in the apical buds than lateral buds.

## Phototropism

- Plant bend towards unilateral light.
- This is due to higher concentration of auxin on the shaded side.

# Effects of Auxin on Plant Growth & Development

## Geotropism

- **Movement of a plant's parts in response to gravity is known as geotropism/ gravitropism.**
- **Stem and roots accumulate IAA on the lower side in response to gravity.**
- **Increased auxin concentration on the lower side in stems causes those cells to grow more than cells on the upper side.**
- **Upper side of roots grow more rapidly than the lower side.**
- **roots ultimately grow downward *i.e.*, positive gravitropism**



# **Effects of Auxin on Plant Growth & Development**

## **Root initiation**

- **Application of IAA to cut end of a stem promotes root formation.**

## **Control or Prevention of Abscission**

- **Abscission does not occur when auxin content is high on distal end and low in the proximal end of abscission zone.**



# Effects of Auxin on Plant Growth & Development

## Callus Formation

- **Undifferentiated mass of parenchymatous tissue is known as callus.**

## Sex Expression

- **Auxin induced the changing of sex ratio of flowers towards femaleness, *i.e.* increase the number of female flowers.**

## **Use of Auxin in Agriculture**

### **Rooting of Cuttings**

- **Application of NAA (in Mango) and IBA (in Guava) in stem cutting causes 100% success in vegetative propagation.**

### **Prevention of Sprouting**

### **Seedless Fruit Production (Parthenocarpy)**

- **In case of Banana, Grapes, Strawberry, Brinjal,**

**Grapes – Application of IAA, IBA, and NAA show 100% success.**

## **Use of Auxin in Agriculture**

### **Promotion of Flowering**

- **Application NAA causes uniform flowering in Pineapple leading to development of uniform sized fruits.**
- **2, 4 -D is also used to increase the femaleness in monoecious Cucurbits.**

### **Prevention of Premature Dropping of Fruits**

- **In case of Apple and Cotton - NAA**
- **In case of Citrus fruits – 2,4–D/ 2,4,5-T**

### **Germination**

- **IAA, IBA, is most widely used in soaking seeds for germination.**





## **Use of Auxin in Agriculture**

### **Fruit Setting**

- **2, 4, 5-T is used for improved fruit setting in berries.**

### **Thinning of Flower, Fruit and Leaves**

- **2, 4-D is used for defoliation of Cotton plant before boll harvesting.**
- **NAA is used for fruit thinning in Apple.**

## **Use of Auxin in Agriculture**

### **Weedicide**

- **2, 4-D, MCPA (Methyl Chloro-Phenoxy Acetic Acid) are weed killer.**
- **2,4-D is highly toxic to broad leaved plants or dicotyledons.**

### **Tissue Culture**

- **Auxin along with cytokinin shows successful callus formation, root-shoot differentiation etc.**

## **GIBBERELLINS**

- **Discovered by Kurosawa, a Japanese Plant Pathologist in 1928.**
- **Rice plants infected by the fungus *Gibberella fujikuroi* (Synonym: *Fusarium moniliforme*) showed excessive stem elongation and this Symptom is called '*Bakane*' diseases.**
- **Chemical was extracted & purified and named as Gibberellic Acid (GA).**
- **Now 80 different Gibberellins are available- GA1 to GA80 is available.**
- **The most commonly occurring gibberellins is GA3.**



# Physiological effects of Gibberellins

- **Removes Genetic Dwarfism**
- **Bolting and Flowering**
- **Light inhibited stem growth**
- **Induces Parthenocarpy**
- **Mobilization of storage compounds during germination**

## **Cytokinins**

**Haberlandt 1913 noticed soluble substance in potato tubers which processes the capacity to induce the cell division.**

**Bonnor 1939 isolated the traumatic acid from bean fruits, can induce the meristematic activity, when a tissue is injured**

**Skoog 1948 worked on the stem internode culture of tobacco**

**Miller *et. al.*, 1955 isolated another substance from yeast and named as kinetin. It was effective in induction of cell division in very low concentration.**

**Subsequent to its discovery, many analogous of kinetin, active in promoting cell division were synthesized.**

- **Cell Division, Cell Enlargement, Root initiation and growth, Shoot initiation and growth, Breaking Dormancy**

**Kinetin a degradation product of DNA**

## **Growth Retardant**

### **1. ETHYLENE ( $\text{CH}_2=\text{CH}_2$ )**

- Growth retardant.
- Ethylene promotes ripening.

### **2. ABSCISSIC ACID (ABA)**

- Growth retardant.
- Induce stomata closing.
- Inhibition of bud growth and shoot formation.



**Acknowledgements**  
to

**1. Plant Physiology by Robert M Devlin1972.**