

# CHAPTER 5.1 – TYPES OF RESPONSES

## Types of plant responses

There are two types of responses

- Δ Tropism responses
- Δ Nastic responses

## Tropism responses

- ↳ Tropism responses are the responses of certain parts of a plant (roots and shoots) that respond towards or away from a stimulus

## Characteristics of tropism responses

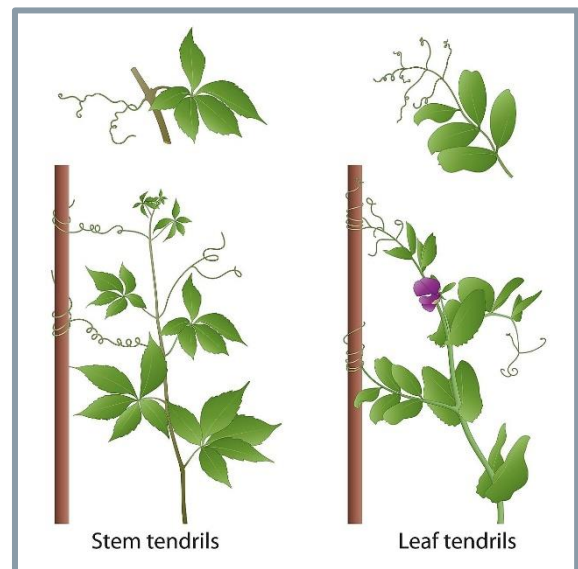
- ↳ The response is permanent and influenced by plant hormones
- ↳ The response is slow and not apparent
- ↳ The response direction is dependent on the direction of the stimulus
- ↳ Growth towards direction of stimulus (positive tropism)
- ↳ Growth away from stimulus (negative tropism)

## Types of tropism responses

### THIGMOTROPISM

- ⊡ Thigmotropism is the plant response to touch

- ⊡ For example, tendrils exhibit positive thigmotropism by coiling or wrapping around an object (wooden stack) for support



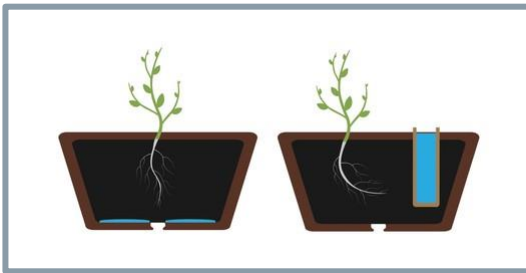
### GEOTROPISM

- ♥ Geotropism is the plant response to gravity
- ♥ Shoots show negative geotropism
- ♥ Roots show positive geotropism



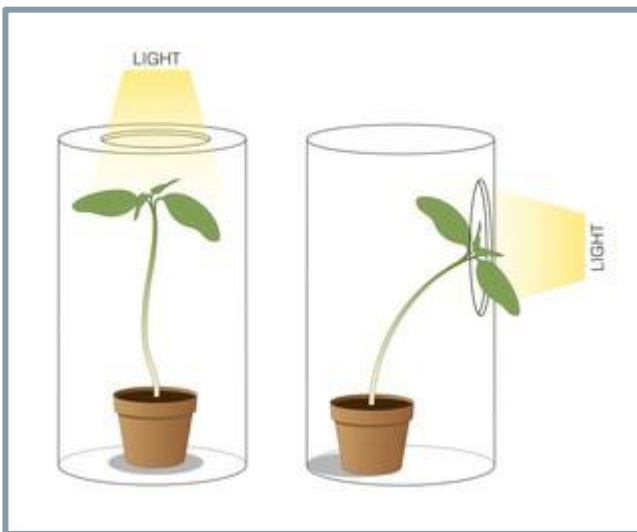
### HYDROTROPISM

- ✚ Hydrotropism is the plant response to water
- ✚ Roots show positive hydrotropism because they grow towards water



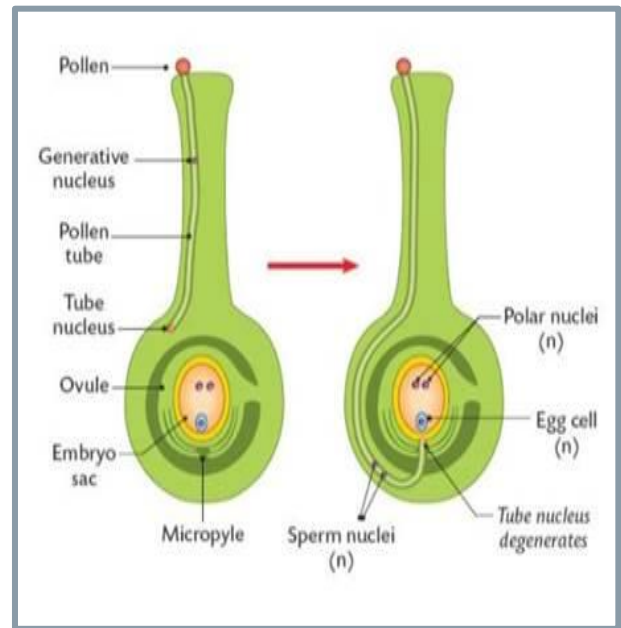
## PHOTOTROPISM

- ◇ Phototropism is the plant response to light
- ◇ Shoots show positive phototropism because they grow towards light



## CHEMOTROPISM

- Chemotropism is the plant response to chemical
- Roots show positive chemotropism where they grow towards mineral salts
- Roots show negative chemotropism when they grow away from chemical substances (poison)
- For example, after a flower is pollinated, a pollen tube grows downward through stigma and style and enters the ovule through micropyle



## Nastic responses

- Nastic responses are non-directional responses to the intensity of a stimulus

## Characteristics of nastic responses

- » Not all nastic responses are growth responses
- » This response is quicker and more apparent compared to tropism response
- » Some nastic responses are intended for survival

## Types of nastic responses

### PHOTONASTY

- Flower petals engage in photonasty as a response to light
- For example, Japanese roses open when they receive maximum sunlight and close at night



### SEISMONASTY

- Seismonasty is a plant response that occurs due to a mechanical stimulus (shock, touch, wind and raindrops)
- Seismonasty responses can be seen on leaves, stigma and stamens
- For example, mimosa plant closes its leaves when it gets touched



### NYCTINASTY

- Nyctinasty is a circadian rhythm that responds towards the onset of darkness
- Normally, this response can be seen on legume plants
- For example, the river tamarind closes its leaves at night and unfurls them during daytime



### THERMONASTY

- ✓ Thermonasty is the plant response towards changes in the surrounding temperatures
- ✓ For example, tulips open when there is an increase in temperature and close when the temperature drops



### THIGMONASTY

- ❖ Thigmonasty is the plant response towards vibration
- ❖ This response can be seen in carnivorous plants (Venus flytrap)
- ❖ The exerted stimulus causes it to clamp its leaves shut and trap the insect inside it



# CHAPTER 5.2 – PHYTOHORMONE

## Phytohormones

- ❑ Phytohormones (a.k.a. plant hormones) are chemical substances that stimulate and coordinate responses in plants, at low concentrations
- ❑ Generally, phytohormones are synthesised in a certain plant organ and transported to a target organ through the phloem
- ❑ There are five types of phytohormones
  - 1) Auxin
  - 2) Gibberellin
  - 3) Cytokinin
  - 4) Abscisic acid
  - 5) Ethylene

## The functions of phytohormones

### AUXIN

- ↘ Functional in phototropism and geotropism
- ↘ Stimulates development of the apical dominance in shoots and roots
- ↘ Stimulates growth and elongation in root and shoot cells
- ↘ Stimulates development of adventitious roots at the end of stem cuttings
- ↘ Stimulates cell division in cambium during secondary growth
- ↘ Inhibits abscission of fruits and young leaves

- ↘ Inhibits growth of lateral buds

### GIBBERELLIN

- ⊕ Stimulates growth and elongation in the stem cell
- ⊕ Stimulates development of leaves, flowers, and fruits
- ⊕ Stimulates development and germination of seeds
- ⊕ Causes growth of flowers in dwarf plants
- ⊕ Inhibits development of roots

### CYTOKININ

- » Stimulates division and elongation of root and stem cells when auxin is present
- » Stimulates seed germination and growth of lateral buds
- » Inhibits development of apical dominance
- » Delays leaf senescence

### ABSCISIC ACID

- ⊞ Stimulates abscission of mature fruits, leaves and flowers
- ⊞ Induces seed dormancy and stomatal closing during drought season
- ⊞ Inhibits growth of plants
- ⊞ Inhibits growth of buds and seed germination

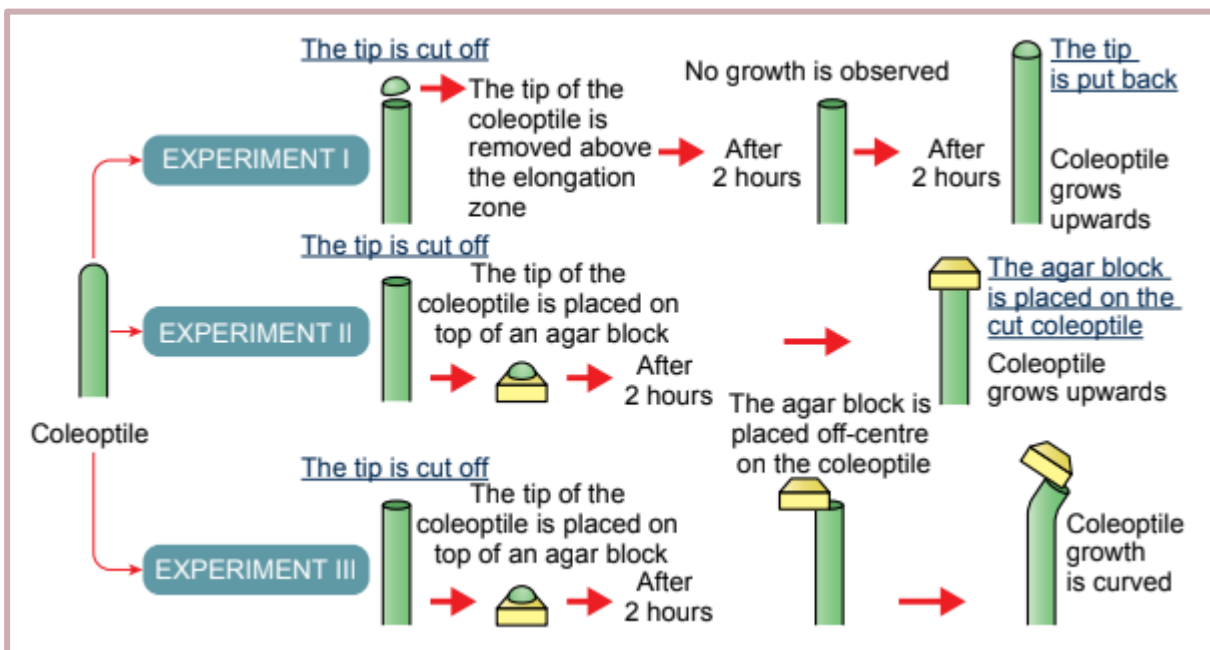
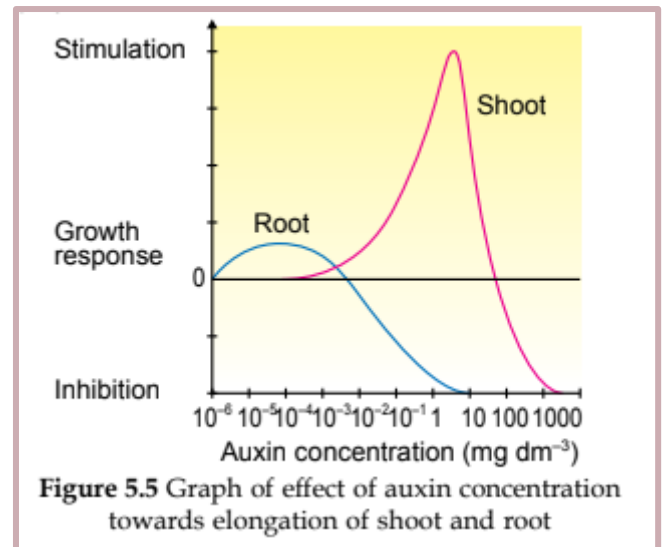
### ETHYLENE

- ◇ Stimulates ripening in fruits and senescence process in plants
- ◇ Stimulates abscission of leaves and fruits

# Effects of auxin on growth response

- Plants respond to stimulus in the form of growth
- This growth response is controlled by the auxin
- An experiment has been conducted to study the effects of auxin on coleoptile growth at the shoot tip
- This experiment shows that auxin which has been synthesised at the coleoptile tips stimulate cell elongation
- Auxin distribution influences the direction of the shoot growth
- Uniform distribution of auxin causes the coleoptile to grow upwards
- The area which receives less or none of the auxin
- Tropism is closely related to auxin distribution

- Externals stimuli (light and gravity) influences the auxin distribution in plants
- Auxin produces different effects to the cells in the shoots and the cells in the roots
- High auxin concentrations stimulate cell elongation in the shoots but also inhibits cell elongation in the roots

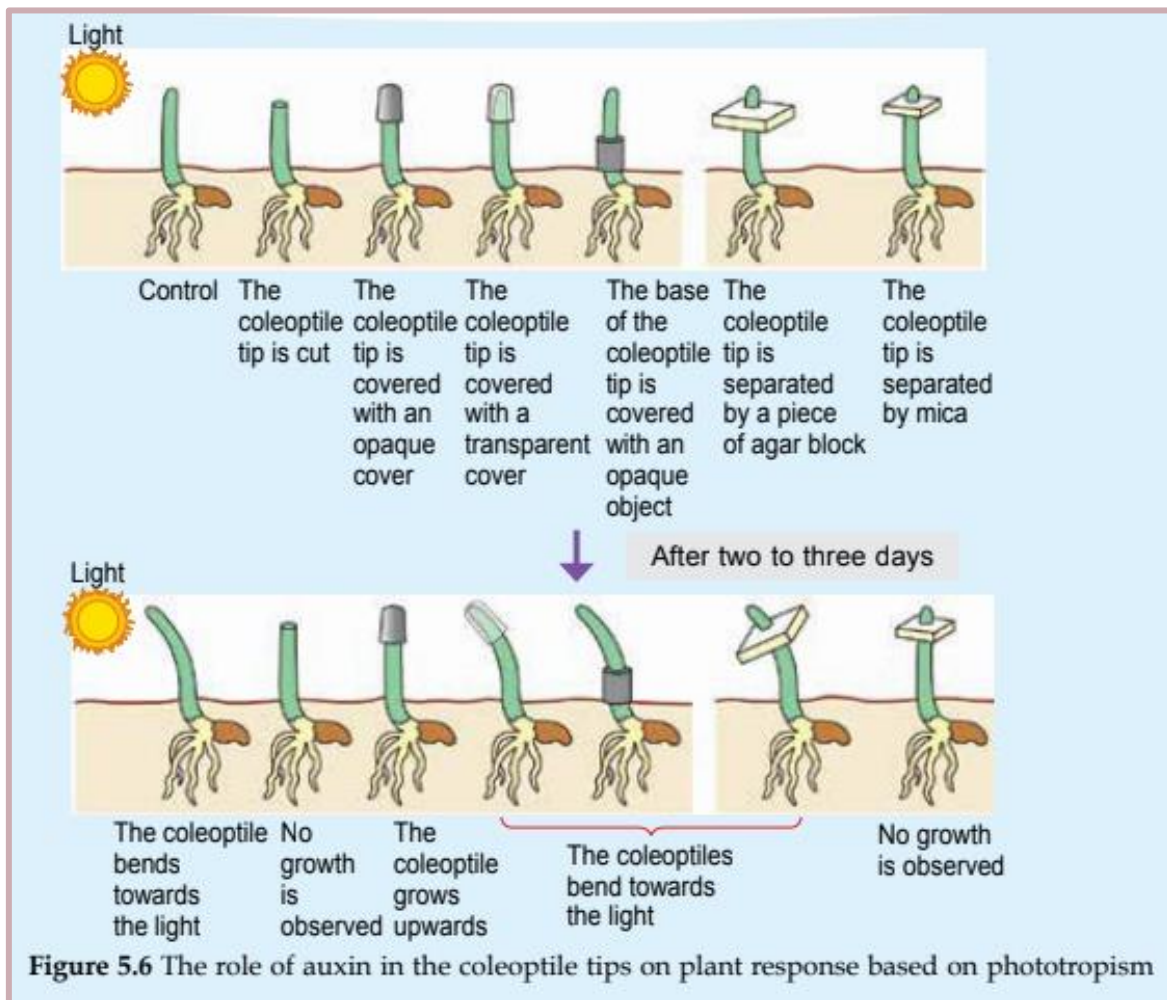


# The role of auxin in plant responses

## THE ROLE OF AUXIN IN PHOTOTROPISM

- The response direction of shoot tip depends on the direction of the light stimulus
- The distribution of auxins in the shoots is uniform if the shoots are exposed to the light from all directions
- This causes the shoots to grow upwards

- When the shoots are exposed to the light from only one direction, the auxin will move away from the light
- The auxin concentration is higher on the shaded side
- The concentration of auxin becomes uneven on the shoots
- The cells in the shaded side elongate more than the cells in the bright side
- As a result, the shoots bend towards the light
- The shoots show positive phototropism



### THE ROLE OF AUXIN IN GEOTROPISM

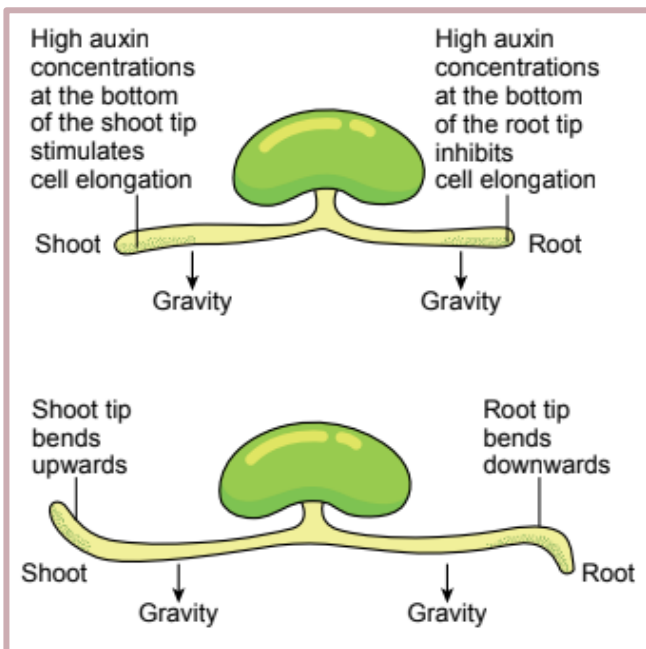
- Auxin also controls plant response to gravity
- Seeds germinate horizontally in the soil
- Due to the pull of gravity, auxin pools at the bottom side of the tips and roots
- Roots grow downwards following the pull of gravity and exhibiting positive geotropism
- Meanwhile, shoots grow upwards against the pull of gravity, exhibiting negative geotropism

### IN SHOOTS

- ❖ High auxin concentrations cause cells at the bottom to grow faster and also allow the shoot to bend upwards

### IN ROOTS

- Δ High auxin concentrations at the bottom of roots inhibit root cell elongation and cause roots to bend downwards



# CHAPTER 5.3 – APPLICATION OF PHYTOHORMONES IN AGRICULTURE

## Application of phytohormones in agriculture

### AUXIN

- ⊕ Encourages **growth** in crops
- ⊕ Promotes **root growth** (asexual reproduction) on woody plant stems for horticultural crops
- ⊕ Produces **fruit** without seeds via **parthenocarpy**
- ⊕ Used as **weed killer**
- ⊕ Induces **dormancy** in potatoes during storage or distribution
- ⊕ Promotes **growth** of low-lying and lush plants

### ETHYLENE

- ❑ Used commercially to promote **maturation of fruit** quickly and evenly
- ❑ Promotes **simultaneous flowering** in plants in the field

### GIBBERELLIN

- ↘ Treats **mutated dwarf plants** to grow to normal heights
- ↘ Promotes **rapid elongation** of flower stems
- ↘ Used to produce **larger grapes**
- ↘ Promotes **germination of seeds** (salad, oats and tobacco) during **low temperatures** and **low light intensity**

### CYTOKININ

- ◇ Promote **division** and **differentiation of cells** via tissue culture technique
- ◇ Used together with auxin to **form plant organs** (roots and stems) via tissue culture technique
- ◇ Used to **delay leaf senescence** in newly cut flowers

### ABSCISIC ACID

- ✚ Inhibits **germination** and **growth**

