

Chapter 33 - Plant Responses

Learning objectives


- To describe the structures needed for response
- To identify some of the external factors that regulate growth in plants
- To define the terms 'phototropism', 'geotropism', 'thigmotropism', 'hydrotropism' and 'chemotropism', and to give examples of phototropism and geotropism
- To distinguish and identify growth promoters and growth inhibitors
- To define 'growth regulator' and describe growth regulation in flowering plants
- To give two examples of the use of plant growth regulators
- To describe four ways in which plants are anatomically or chemically adapted to protect themselves
- HIGHER ▶** ● To describe the plant growth regulator auxin in terms of its production sites, function and effects
- HIGHER ▶** ● To explain how a plant responds to any one external stimulus
- To investigate the effect of the growth regulator IAA on plant tissue.

Chapter 33 - Plant Responses

The structures required for response

The structures needed by organisms in order to allow them to respond include:

- A chemical or hormonal system (present in plants and animals)
- A nerve and sense organ system (only found in animals)
- A method of movement, which includes growth along with muscular and skeletal systems (a muscular and skeletal system is only found in animals)
- A defence or immune system.



A **stimulus** (plural: **stimuli**) is anything that causes a reaction in an organism or in any of its parts.

A **response** is the activity of a cell or organism as a result of a stimulus.



External Factors

Light, Day Length, Gravity, Temperature

Internal Factors

Hormones

Tropisms



A **tropism** is a change in the growth of a plant in response to an external stimulus.

A **positive tropism** occurs when the growth is towards the stimulus.

A **negative tropism** occurs when the growth is away from the stimulus.

The main advantage of tropisms is that they allow plants to obtain more favourable growing conditions. For example:

- Stems grow towards light so they can produce more food by photosynthesis
- Roots grow towards gravity so they can penetrate deeper into the soil for better anchorage and absorption.



Phototropism and Geotropism



Phototropism is the change in growth of a plant in response to light, usually from one direction (i.e. unidirectional light).



Stems are **Positively Phototropic**.
They grow **towards** light.
Many roots are Negatively phototropic.
They grow away from light.



Geotropism (or gravitropism) is the change in growth of a plant in response to gravity.

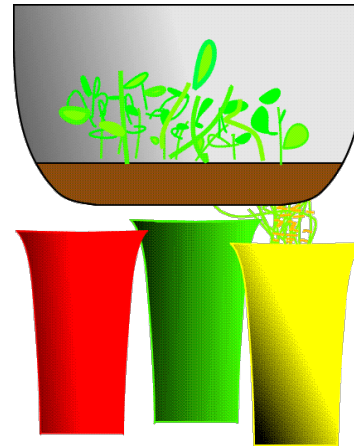
Roots are positively geotropic.
They grow towards gravity.
Many stems are **Negatively Geotropic**.
They grow **away from** gravity.

Other Tropisms

Thigmotropism is a change in growth of a plant in response to touch.



Hydrotropism is a change in growth of a plant in response to water.



The yellow beaker has water in it. All the roots grow towards the water.

Chemotropism is a change in growth of a plant in response to chemicals.

Plant Hormones



A **growth regulator** is a chemical that controls the growth of a plant.

- They are active in very small amounts.
- Their effects depend on their concentration. This means the same regulator can have opposite effects at high or low concentrations.
- Their effects depend on the location in the plant in which they are acting. For example, the same concentration of plant regulator can have opposite effects in the stem and root.

Auxins and IAA

A chemical called **IAA**, (Indoleacetic Acid) causes the cells to grow.

IAA belongs to a family of growth regulators called **Auxins**.

It is produced at the plants growing tips (meristems).

It causes cell elongation, root growth, develops fruit, inhibits side branching, causes phototropism and geotropism.



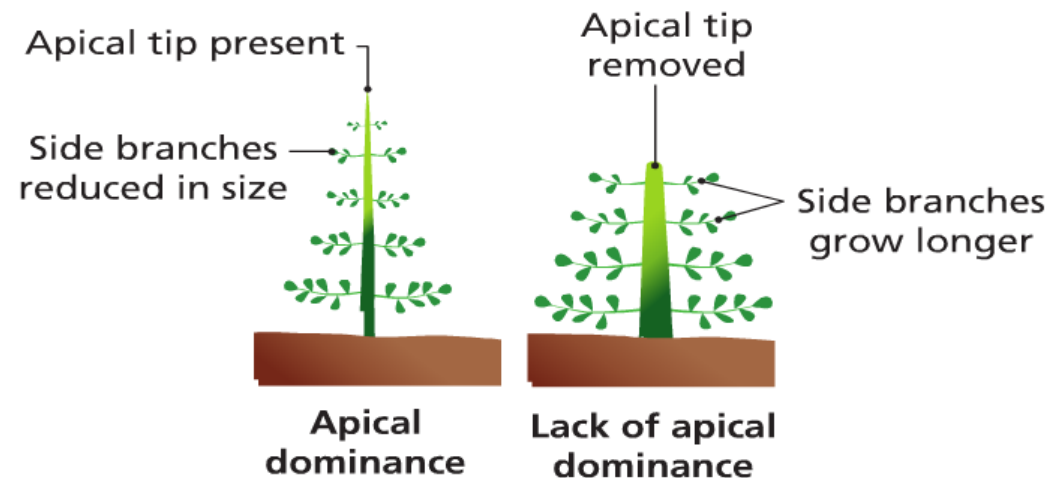
A **growth promoter** is a chemical that causes increased growth in plants.

Fruit Formation

Seedless fruits (e.g. grapes) are grown using auxins. The auxin is added to the flowers before they are pollinated and this stops seeds forming.



Apical Dominance



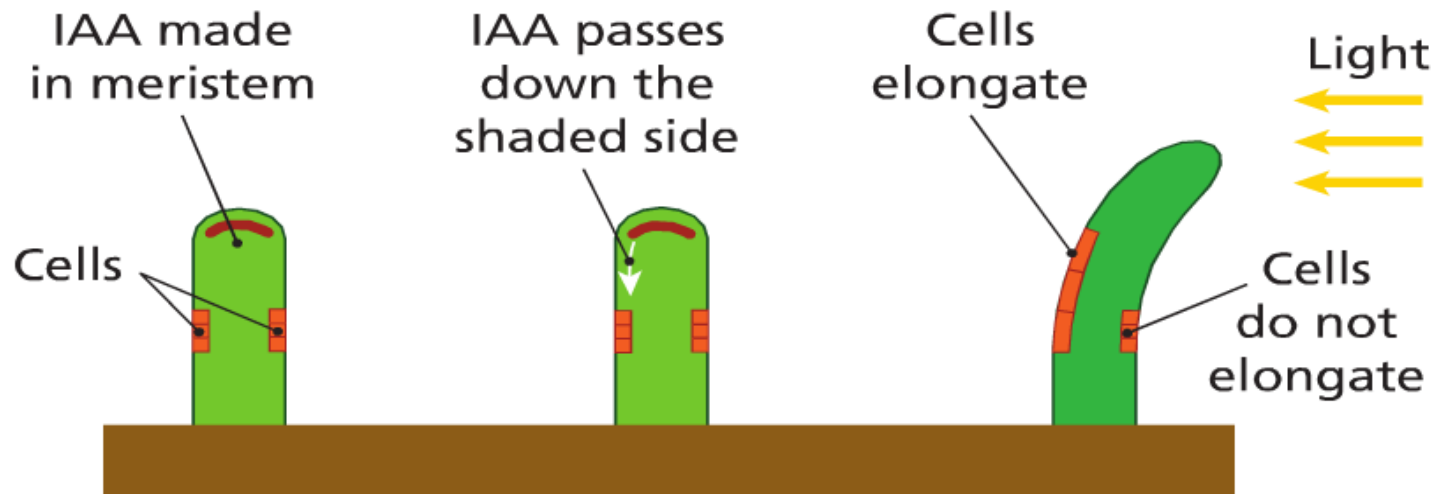
The tip (meristem) of a plant will continue to grow **straight** because of auxin. It stops side branches from forming near the tip. Side branches are bigger further away from the growing tip.

Phototropism

Auxin loosens cell walls and allows the cell to stretch. It activates an enzyme that breaks down cellulose. So the cells in the shade grow longer.

Steps in Phototropism

1. IAA is produced in the stem tip.
2. The IAA spreads down the side of the tip that is in the **shade**.
3. The cells in the shade grow longer and cause the stem to bend over towards the light.



Growth Inhibitors



A **growth inhibitor** is a chemical that causes a reduction in growth of plants.

Ethene (ethylene)

This growth regulator is a gas made in stem nodes, ripe fruits and decaying leaves. It causes fruit colour, fruit flavour, and ripens fruit.

Bananas are picked before being ripe and transported to other countries. They are then sprayed with ethene gas to turn them yellow for the shops.



Abscisic acid

Abscisic acid is produced in leaves, stems and root caps. It is often called the stress regulator of plants. The functions of abscisic acid include:

- Causing plants to respond to harmful conditions
- Causing stomata to close in dry conditions (to retain water)
- Causing the production of bud scales, which protect the buds in winter
- Inhibiting seed germination, which allows the seeds to remain dormant in the soil during winter.

Commercial Uses of Inhibitors

Bananas

Bananas are sprayed with ethene gas to turn them yellow for shops.



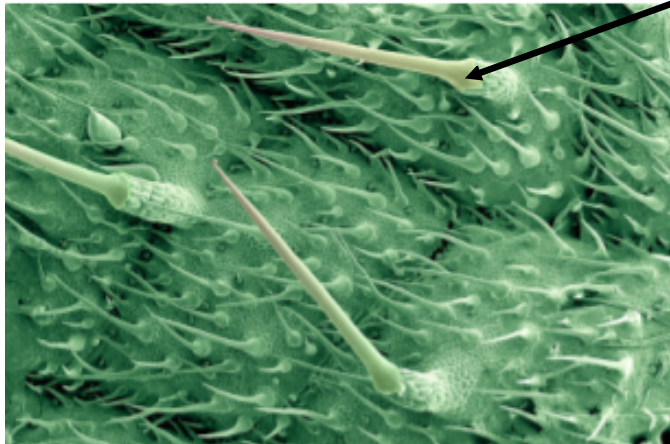
Rooting Powders

Contain synthetic growth promoters such as NAA. This stimulates root growth on cuttings and is called rooting powder.

Plant Protection

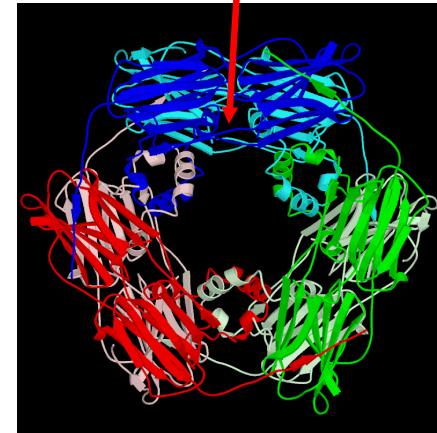
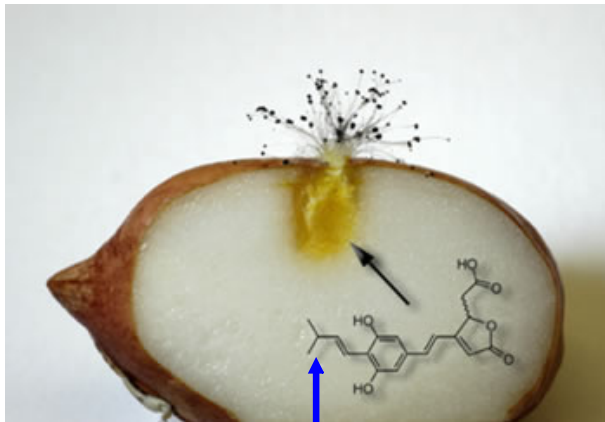
You are required to know **4 methods** of Plant Protection

1. Plants have a **protective layer** of bark or dermal tissue. This is often covered in a waxy cuticle for added protection. Some have adaptations such as thorns.



2. A shortage of water causes the **guard cells** of the stomata to close and this stops the plant losing water.

3. High temperatures can cause enzymes to be denatured. Plant enzymes are protected by **'heat-shock' proteins** when temperatures get too high. This stops them from losing their shape.

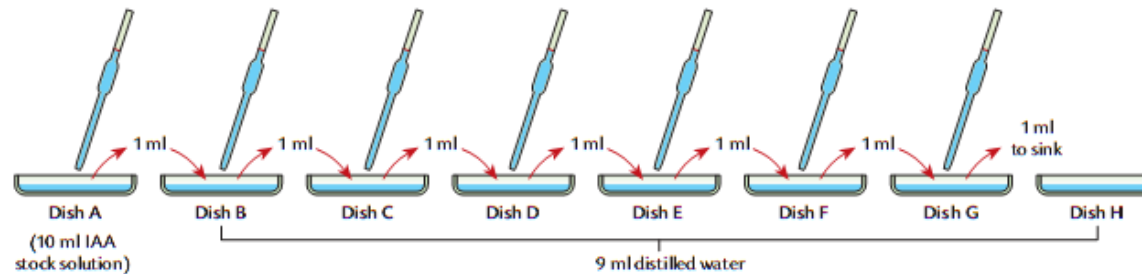


4. When a plant is infected it can produce stress proteins called **phytoalexins**. These proteins can stimulate cell walls to grow and 'call' other plant cells to respond to the infection.

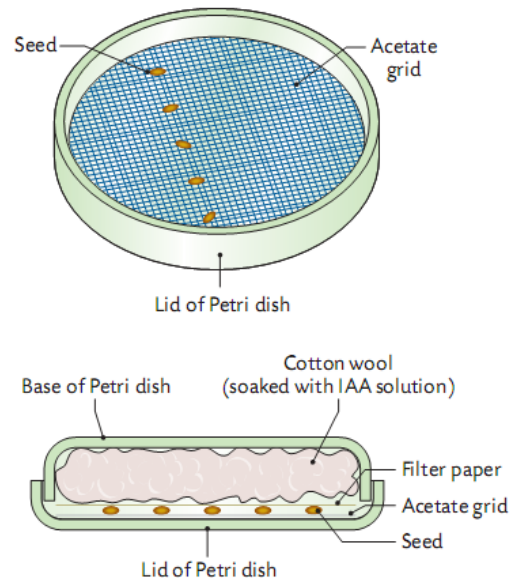
IAA Experiment

To investigate the effect of IAA concentration on plant tissues.

1. Different concentrations of IAA are prepared.



2. Seeds are grown in petri-dishes with different concentrations of IAA.



3. Changes in length of seedlings shoots and roots are recorded.



Results

At low concentrations the roots grow larger and shoots stay short.

At higher concentrations the shoots grow larger and roots stay short.