

Plants response to the environment

Scope

TOPIC	SUBTOPIC	KEY INFORMATION
RESPONDING TO THE ENVIRONMENT: PLANTS	Plant hormones	<ul style="list-style-type: none"> • Functions of auxins, gibberellins and abscisic acid • Control of weeds
	Role of auxins in phototropism and geotropism	<ul style="list-style-type: none"> • Especially when diagrams are given. • Investigations relating to auxins
	Plant defence mechanisms	<ul style="list-style-type: none"> • Role of the following: <ul style="list-style-type: none"> ✓ Chemicals ✓ Thorns



Adapted from DBE revision guidelines

Plants response to the environment

Notes

Plants are able to respond to **stimuli** such as **water**, **sunlight**, **gravity**, **chemicals** and **touch**. Plants use chemicals called **hormones** (also known as plant growth regulators) and these hormones affect how a plant grows, by stimulating plant cells to divide, enlarge, elongate and to stop growing.

Plant hormones - auxins, gibberellins, abscisic acid will be discussed

Auxins

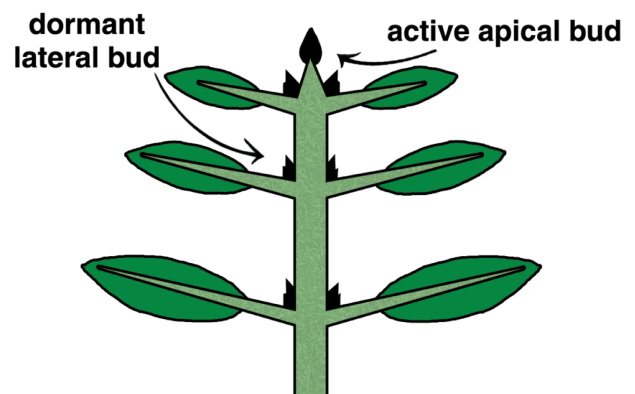
Auxins are produced in the growing tips of stems and roots and in apical buds and are the main hormones that cause plants to grow. They stimulate or can prevent (inhibit) growth.

The main functions of auxins:

- apical dominance
- growth regulation (responsible for phototropism and geotropism)

Other functions include:

- cell division (mitosis)
- formation of adventitious roots in cuttings
- development of flowers and fruits
- abscission of leaves and ripe fruits (cause leaves and fruit to fall off)



Apical dominance

auxins are produced at the tip of the stem. The auxins move downward and inhibit the growth of the lateral branches. This process is called **apical dominance**.

Auxins inhibit growth of lateral branches.

Removal of tip of the stem results in growth of lateral branches.

Tropism

Plants can respond to many different stimuli. We focus on two:

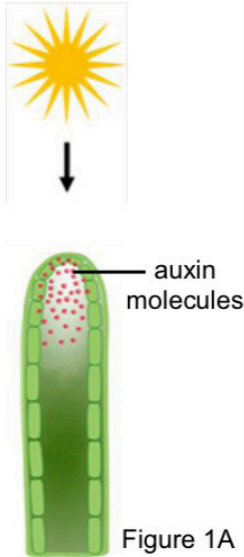
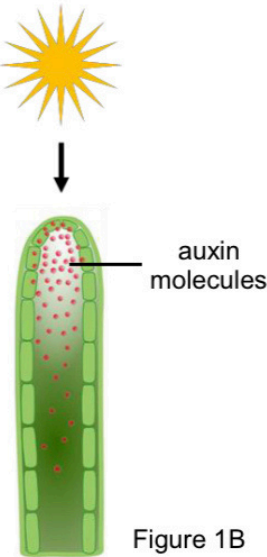
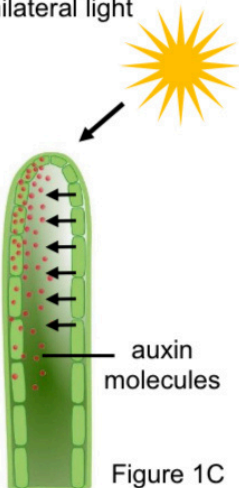
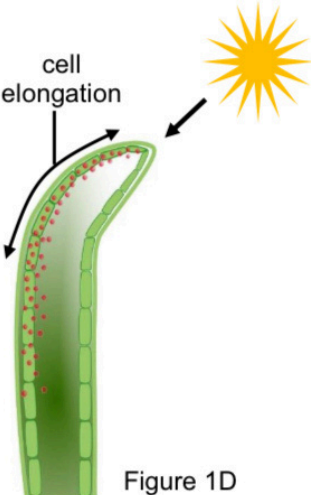
- **phototropism** - a response to light
- **geotropism** - a response to gravity

Plant response to the environment

Phototropism

Phototropism is the growth of parts of a plant towards a light stimulus. When the stem of a plant is exposed to unilateral light, the stem will bend toward that light.

Role of auxins in phototropism

Direction of light stimulus	Effect of light on auxins	Observations
Shoot A – with sunlight directly overhead  <p>auxin molecules</p> <p>Figure 1A</p>	<ul style="list-style-type: none"> Auxins produced at the tip of the stem / shoot Auxins move downwards evenly This distribution brings about equal growth on all sides of the stem 	<p>The stem / shoot A grows straight upward towards the light</p>  <p>auxin molecules</p> <p>Figure 1B</p>
Shoot B – when the stem is exposed to unilateral light  <p>auxin molecules</p> <p>Figure 1C</p>	<ul style="list-style-type: none"> The auxin concentration will be high on the shaded side because light destroys auxins or auxins move away from the light More growth occurs on the dark side because auxins stimulate growth on the dark side 	<p>The stem / shoot B bends towards the light</p>  <p>cell elongation</p> <p>Figure 1D</p>

Stems are **positively phototropic** as they bend toward the light and **roots** are **negatively phototropic** as they grow away from the light.

Advantages of stems being positively phototropic:

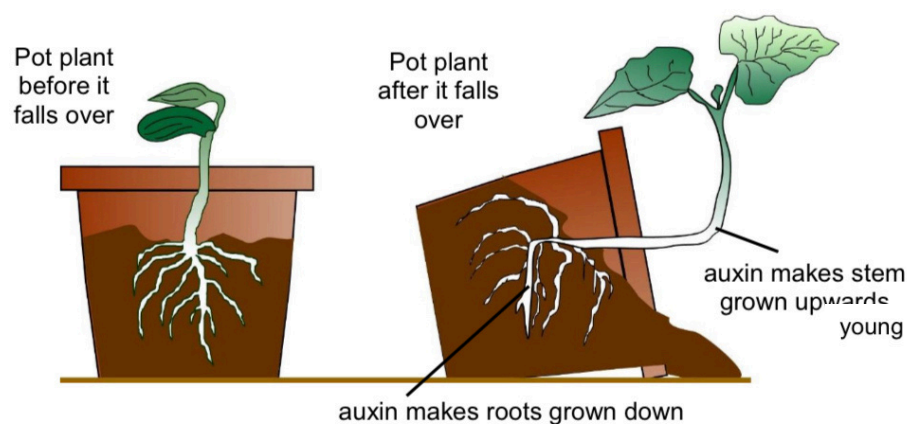
- favourable position for leaves to receive sunlight needed for photosynthesis
- allows easy pollination of flowers
- allows easier seed dispersal

Plant response to the environment

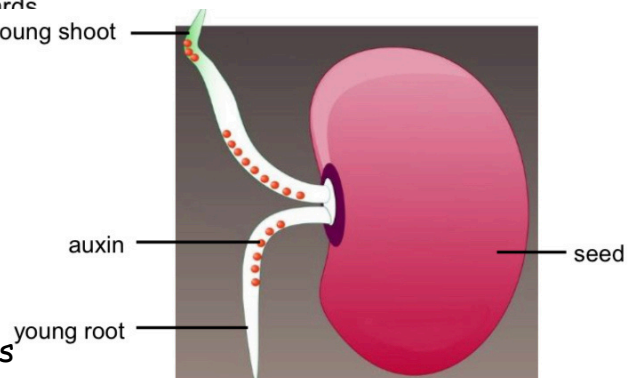
Geotropism

Geotropism is the growth movement of a plant in response to gravity.

When a pot plant is placed on its side and left to grow in a dark environment without any light, the stem will grow upwards and the roots will grow downwards.



Auxins have mass and are pulled down by gravity. As a result, the shoot and root both have a high concentration of auxins on the lower side.



Role of auxins in Geotropism

When the pot plant is upright:

- auxin is produced at the tip of the roots and moves upwards evenly.
- The even distribution brings about equal growth on all sides of the root.
- As a result the root grows downward.

When the pot plant is placed horizontally:

- the auxin concentration will be high on the lower side of the root because auxins are pulled down by gravity.
- More growth occurs on the upper side of the root because auxins on the lower side inhibit growth.
- As a result the root bends downwards.

In the **shoot** high auxin concentration promotes cell elongation on the lower side. The shoot thus bends and grows upwards. It is **negatively geotropic**.

In the young **roots** the lower part has high auxin concentration than the upper part. A high auxin concentration in roots inhibits cell elongation. The upper part with no auxins grows faster. The root then grows downwards towards gravity. Roots are **positively geotropic**.

Roots then grow deep into the soil to absorb water and minerals.

A clinostat is used as a control to cancel the effect of gravity in a root by rotating.

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Other hormones

Gibberelins

Gibberellins initiate the germination of seeds, development of flowers and sprouting of buds.

Abscissic acid

The main function of abscissic acid is to inhibit growth of apical buds. It also promotes seed dormancy.

Weed control

Herbicides can be sprayed over crops or gardens to kill the unwanted weeds. However, these chemicals are often toxic to animals and humans and some plants.

An alternative to these toxic chemicals are plant hormones.

Auxins sprayed on **roots of weeds may inhibit root growth** because high auxin concentration on roots has an inhibitory effect, causing the death of that particular weed.

Plant defence mechanisms

Chemical defence

The primary defence mechanism is the production of **chemical compounds** that poison herbivores and insects and protect plants against pathogens. These chemical compounds (e.g. **tannins**) can affect the feeding, growth and survival of herbivores, insects and pathogens.

Mechanical defence

Other defences include the development of various external structures e.g. thorns that make it difficult for herbivores to eat the plant.

Examples of structures involved in **mechanical defence** in plants include **thorns, prickles** and **spines**.



Figure 4A: Thorns

Thorns are modified branches or stems that form hard, pointed sharp edges that can pierce the skin or the roof of the mouth of a herbivore. Thorns make it difficult for larger herbivores to get their mouths to the leaves in between the thorns, without hurting themselves.



Figure 4B: Prickles

Prickles are modified extensions of the cortex and epidermis of a plant that shape into a sharp, needle-like structure. These are often found on rose bushes.

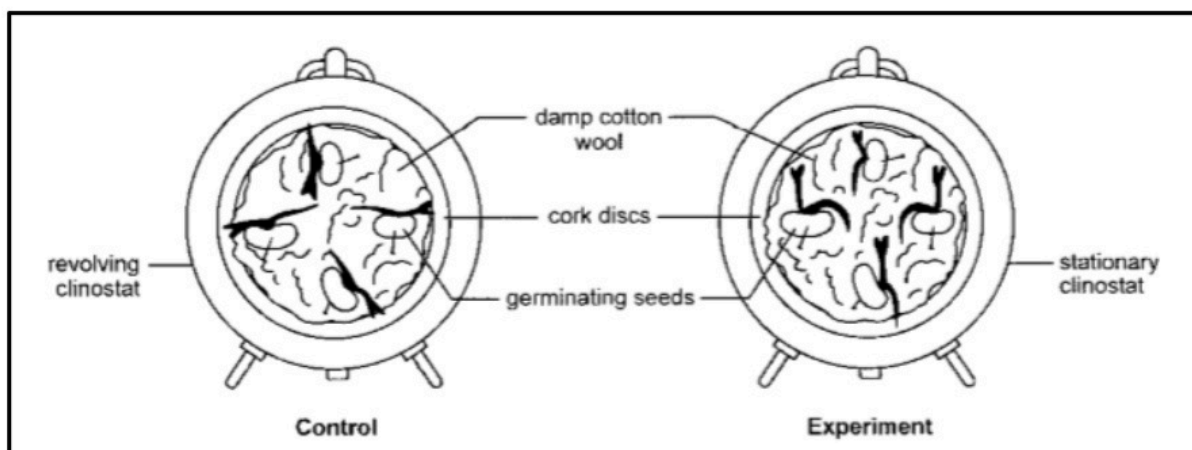
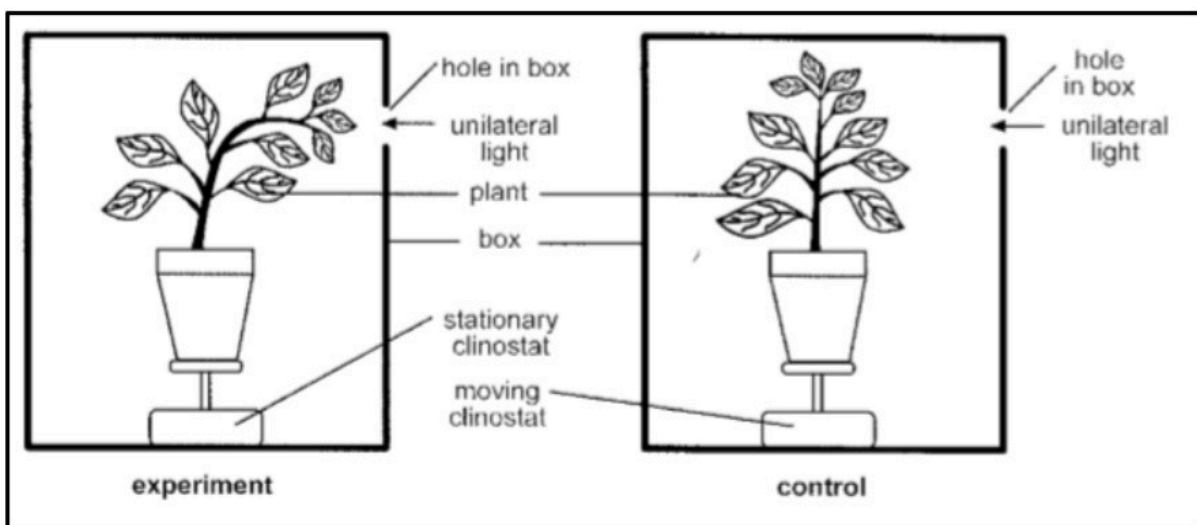
Spines are modified leaves that have a cylindrically shaped hard and sharp point. These structures are often found on aloes and cacti. They are generally rather thin and are difficult to remove.

Plant response to the environment

Experiments

It is important to understand how this investigation is done and how it works.

The use of a clinostat



If the clinostat is rotating the root grows horizontally as a rotating clinostat cancels out gravity

Plant response

Terminology

Biological term	Description
Abscisic acid	The plant hormone that promotes seed dormancy/ A plant hormone that causes leaves to fall off trees in autumn.
Apical dominance	Is the phenomenon whereby the main, central stem of the plant is dominant over other side stems
Auxins	The plant hormone that promotes root and stem growth
Geotropism	The growth of part of a plant in response to gravity.
Gibberellins	A plant growth hormone that stimulates seed germination.
Herbicide	Chemical used to kill weeds
Hormone	Chemicals that allow a plant to respond to some stimulus in the environment
Phototropism	The growth of a plant in response to light
Tropism	The growth movement of a plant or part of a plant in response to an environmental stimulus