TROPISM

Most plants do not respond to stimuli as quickly as this, because their response normally involves **changing their rate of growth.** Different parts of plants may grow at different rates, and a plant may respond to a stimulus by increasing growth near the tip of its shoot or roots. Imagine a plant growing normally in a pot. Usually, most light will be falling on the plant from above. If you turn the plant on its side and leave it for a day or two you will see that its shoot start to grow upwards.

Figure 18.27 *This bean has responded to being placed horizontally. The growing shoot has started to bend upwards.*

There are two stimuli acting on the plant. One is the direction of the light that falls on the plant. The other stimulus is gravity. Both light and gravity are directional stimuli (they act in a particular direction). The growth response of a plant to a directional stimulus is called **a tropism.** If the growth response is towards the direction of the stimulus, it is a **positive tropism**, and if it is away from the direction of the stimulus, it is a **negative tropism**. The stem of the plant is showing a **positive phototropism** and a **negative geotropism,** which both make the stem grow upwards.

The aerial part of a plant (the shoot) needs light to carry out photosynthesis. This means that in most species, a **positive phototropism** is the strongest tropic response of the shoot. If a shoot grows towards the light, it ensures that the leaves held out at an angle to the stem, will receive the maximum amount of sunlight. This response is easily seen in any plant placed near a window or another source of 'one-way' or **unidirectional light**.

In darkness or uniform light, the shoot shows a negative geotropism, As you might expect, the roots of plants are strongly positively geotropic. This response makes sure that the roots grow down into the soil, where they can reach water and mineral ions, and obtain anchorage.

The roots of some species that have been studied are also negatively phototropic, but most roots don't respond to directional light at all. In the same way, some experiments have shown that roots of a few species show positive hydrotropism (attraction to water).

Thigmotropism is a growth response to touch (or contact). This is most obvious in climbing plants, such as vines, peas and beans, where the shoot of the plant grows towards any object it touches. This tropism results in the stem coiling around a stick or another plant, which provides it with support. Stems are positively thigmotropic, whereas roots are negatively thigmo tropic. When roots touch an object, such as a stone in the soil, they grow away from it. This makes it easier for a root to grow through the soil.

Stimulus	Name of Response	Response of shoots	Response of roots
Light	Phototropism	Grow towards light source (positive phototropism)	Most species show no response, but a few grow away from light (negative photo tropism)
Gravity	Geotropism	Grow away from direction of gravity (negative geotropism)	Grow towards direction of gravity (positive geotropism)
Water	Hydrotropism	None	Some species may grow towards water (positive hydrotropism)
Touch	Thigmotropism	Grow towards direction of touch (positive thigmotropism)	Grow away from direction of touch (negative thigmotropism)

Questions:

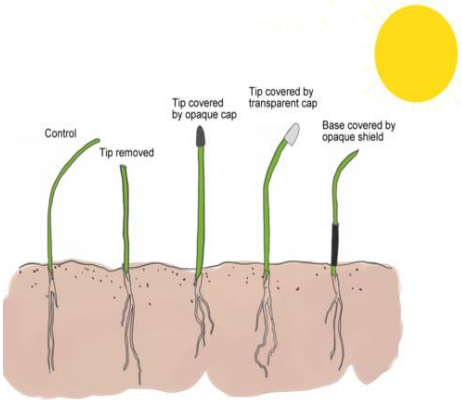
1. What is tropism
2. Shoots show positive phototropism. Why is this response an advantage to the plant?
3. Roots show positive geotropism. Why is this response an advantage to the plant?

DETECTING THE LIGHT STIMULUS – PLANT HORMONES

Plants do not have the obvious sense organs and nervous system of animals, but they respond to light and gravity. Charles Darwin used **cereal coleoptiles**, which are easier to grow and use in experiments.

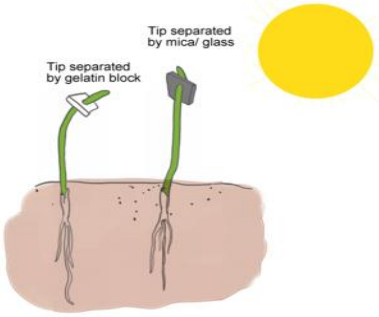
Coleoptiles is a protective sheath that covers the first leaves of a cereal seedling. It protects the delicate leaves as the shoot emerges through the soil.

Phototropism - Experiments



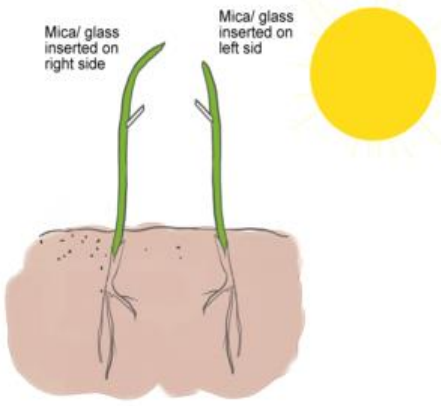
Some of the early phototropism experiments were conducted by Charles Darwin (best known for his contributions to evolutionary theory) and his son. He noticed that if light is shone on a coleoptile (shoot tip) from one side the shoot bends (grows) toward the light. The 'bending' did not occur in the tip itself but in the **elongating** part just below it. Removing the tip or covering it with foil meant that the shoot could no longer 'bend' toward the light. Covering the elongating part of the shoot did not affect the response to light at all!

Darwin Concluded that: "Some influence is transmitted from the tip to the more basal regions of the shoot thereby regulating growth and inducing curvature"



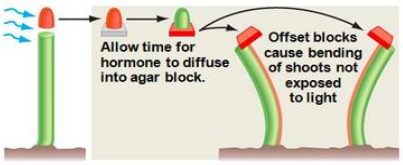
Boysen-Jensen continued investigating these responses. He cut the tips off coleoptiles and placed a thin piece of silver or mica between the coleoptile and the lower shoot. The result was that the shoot did not grow or curve toward the light.
When he repeated the experiment using a block of gelatin / agar instead, the result was that the shoot grew and curved towards the light. Thus he concluded that the Darwin's 'influence' was a water soluble chemical, capable of diffusing through the agar / gelatin from the tip where it was produced to the lower, elongating part of the shoot where it had its effect.

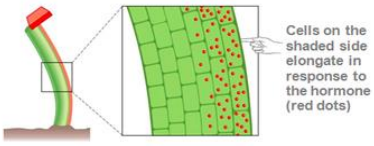
This water soluble "'influence" was later identified as the plant hormone auxin.



He also noticed that placing a thin piece of mica part way into the dark side of the coleoptile blocked any response whereas placing a thin piece of mica part way into the light side of the coleoptile did not affect the response.

A third scientist (Went) cut the tips of coleoptiles and placed them in the dark, putting a few of the tips on agar (gel) blocks that he predicted would absorb the growth-promoting chemical. He then placed these blocks on top of the tip-less coleoptiles. When the agar block was centred on top the coleoptile grew straight. If the agar block was offset, resulting in an uneven distribution of the chemical on one side, the shoot would curve as though it was growing towards a light source. This proved that the response was due to a water soluble chemical that diffused from the tip of the plant down the dark / shaded side of the coleoptile causing it to curve towards the light.





Went repeated the experiment with agar that had not been treated, which produced no growth. This is known as a *control* and is used as a comparison / to check that it was a chemical within the agar that was responsible and not the agar itself.