Plant Transport and Growth

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About:

Plants need to be able to transport substances around inside of them, and there are many mechanisms in place to allow for this in a plant.

Particle Movement

The particles in a plant need to be able to move around to be able to get to different bits in a plant. There are some different ways this is achieved:

Passive (does not require energy):

Diffusion

The net movement of particles from an area of high concentration to an area of low concentration down a concentration gradient. The steeper the concentration gradient, the faster diffusion occurs.

Osmosis

The net movement of free water particles from an area of *High Water Potential* to a lower *Lower Water Potential* down a water potential gradient.

Active (requires energy):

Active transport requires energy. This energy is gathered from Respiration.

It is the movement of particles from an area of low concentration to an area of high concentration. It requires energy.

Note

How active transport works:

1. Substance enters Binding site of carrier protein.
2. Energy *From Respiration* is used to change the shape of the protein.
3. Carrier protein releases substance on other side of Cell Membrane.
4. The carrier protein returns to its original shape.

This process happens in plant root hair cells, which is why they have a lot of mitochondria.

Cells in Solution:

Cells, when present in solution, act in very different ways. This is to do with Osmosis and diffusion.

Isotonic Solutions:

Isotonic: definition

An Isotonic solution is one in which the Water Potential inside and outside of the cell is the same.

In an isotonic solution, a cell will be flaccid, or floppy.

This is because the Water Potential inside and outside of the cell is equal, so there is no net movement of free water particles.

Hypertonic Solutions:

Hypertonic: definition

A hypertonic solution is one in which the water potential inside of the cell is much higher than the water potential outside of the cell.

In a Hypertonic Solution, a cell will become *plasmolysed*, meaning that the cell membrane will split away from the cell wall.

This is because the osmotic movement will lead to the movement of free water particles out of the cell, as the water potential is higher inside of the cell than outside of the cell.

Hypotonic Solutions:

Hypotonic: definition

A hypotonic solution is one in which the water potential inside of the cell is lower than that outside the cell.

In a hypotonic solution, the cell will become turgid.

This is because free water particles will move from the solution into the cell, as the water potential inside of the cell is much lower than the water potential inside of the cell.

This helps the plant not Wilt

Root Hair Cells:

Taking Up Water:

Root Hair cells need to take up water, so that the cells of a plant can be in a hypotonic solution at all times, this enables them to remain turgid, and stops the plant from wilting. Water is also required for processes such as Photosynthesis.

1. Root hair cells increase the surface area of the rooot
2. Inside the cells is a **low** water potential.
3. Outside the cells is a **high** water potential.
4. The free water particles enter the cell through osmosis

They are adapted for this, as they have a large surface area.

Taking Up Mineral Ions:

Root hair cells need to take up mineral ions from the **humus** and **rock fragments** in the soil, so that the plant can complete processes.

To do this, Active Transport must occur. Active transport requires **energy**. To be able to provide this energy:

The root hair cell is adapted to have a **lot** of *mitochondria*.

Xylem and Phloem Vessels:

Xylem and Phloem vessels are the two types of plant vessel. They are grouped together in areas called Vascular bundles.

Xylem:

Xylem vessels

Transport water and mineral ions from the roots to the rest of the plant.

Adaptations:

- They have no end walls between each cell, allowing the water and dissolved mineral ions to flow through each cell, onto the next.
- Their walls are made of lignin. They are dead, but this provides structural stability, and makes them *waterproof*.
- One way.

Phloem vessels.

Phloem vessels

Phloem vessels transport the products of photosynthesis and Amino acids from the leaves to around the plant

Adaptations:

- They are made up of two main parts:
  - The Sieve Tubes:
    - Full of *Cytoplasm*
    - Have sieve-plates, containing minute pores
    - Are still living
    - Two-way
  - Companion Cells:
    - Have nuclei, and so can control the Sieve tubes
    - Are also living

Transpiration:

Transpiration definition

Transpiration is the Evaporation of *water*, followed by the diffusion of *Water Vapour* out of the Leaves through the Stomata.

Note

The Movement of water is important to a leaf because water:

- Is required for Photosynthesis
- Carries Mineral Ions
- Keeps Cells Turgid
- helps the leaf cool down

Factors that Effect Transpiration:

Temperature:

Higher Temperature leads to a Higher rate of transpiration.

1. As the temperature increases, the water particles in the leaf gain more energy.
2. This leads them to evaporate more *rapidly*
3. The Particles have more kinetic Energy, so diffuse *faster*.

Humidity:

Higher Humidity leads to a *Lower* rate of Transpiration.

1. As the Humiditu increases, there is more water vapour in the air.
2. This means that the *Concentration Gradient* will be less steep.
3. This will lead to slower diffusion.

Air Speed:

Higher Air Speed leads to a higher rate of transpiration.

1. As the Air speed increases, water vapour is *blown away* from the area near the leaf.
2. This increases the *Concentration gradient*.
3. This leads to *faster* diffusion.

Light Intensity:

Higher light intensity leads to a higher rate of transpiration.

1. Stomata *open* when the ligth intensity is higher.
2. *More* Light leads to *more* open Stomata.
3. Transpiration happens at a *Faster rate* as the water can evaporate and diffuse out of the leaf *easier*.

> ⓘ Info
>
> There are *more* Stomata on the underside of a leaf, and the waxy cuticle on the top *prevents* water loss.

The Potometer:

The Potometer is an apparatus used to test the rate of transpiration in a plant.

Considerations:

There are some considerations to make when doing this experiment.

- Cut the plant *Underwater* to prevent *air bubbles* entering the Xylem.

- Make sure that the plant is tight in its connection to the capillary tube.
  - this avoids inaccurate readings for transpiration, as some water may evaporate away.
- The Resevoir is there to allow Repeats.

Stomata:

> **Stomata: definition**
>
> Stomata are Pores on the underside of a *leaf* which are used for Transpiration and absorbing Carbon Dioxide and releasing Oxygen. They are surrounded by Guard Cells.

Placement:

> **Info**
>
> There are *more* Stomata on the underside of a leaf, and the waxy cuticle on the top *prevents* water loss.

Experiment:

An experiment to prove this would be to:

- Cover the:
  - top
  - bottom
  - none
  - of different leaves in sticky-backed plastic
- See which leaves lose the most and least mass after blow drying them, to speed up Transpiration through increasing the Temperature.

Adaptations:

The Guard Cells which surround the Stomata have many adaptations which help them perform their function.

Banana-like Curved Shape:

- This produces a Space between them.
- By becoming turgid or Flaccid, they can change their shape, and therefore the size of their Stomata.

Uneven Cell-Wall Thicknesses:

- The inner wall of the Guard Cell is thicker than the *outer cell*, which means that when the cell swells, it *Swells Unevenly*.

Tropisms and Auxins:

Tropisms: definition

A tropisim is a *Growth Movement* in a Plant in response to a *stimuli*.

Auxin: definition

An Auxin is a *substance* which stimulates Plant cell growth through increasing *elongation* and *Splitting*.

Tropisms:

A Tropism can wither be *positive*, or *negative*.

There are Two types of Tropism you need to know

Phototropism:

When Shoots *grow* towards the Light.
This is a *positive* Phototropism.
(to be able to Photosynthesise)

When Roots *grow* Away from the light.
This is a *Negative* Phototropism
(to be able to anchor the plant and collect water)

Geo/GraviTropism:

When Roots *grow* Towards Gravity.
This is a *positive* Geotropism.
(to be able to Photosynthesise)

When shoots *grow* Away from Gravity.
This is a *Negative* Geotropism.
(to be able to anchor the plant and collect water)

Auxins:

Auxins are 'Chemical messengers.'
They are produced at the tip of the shoot or Root.

The Auxins *diffuse* down the shoot, and then *stimulate* the cells there to Elongate and Grow Faster.

Auxins and Positive Phototropism:

How it works:

1. Auxins are produced at the tip of the shoot.
2. The Auxins *Diffuse* Down the Shoot.
3. They Accumulate on the shaded side of the root, as the *light* destroys them.
4. They Stimulate the cells on the *shaded side* to elongate and grow faster
5. The Uneven Growth causes the shoot tip to *bend* towards the *light*.

Seedlings Experiment:

Three seedlings are kept in different conditions for two weeks.

- One faces a window - Seeding 1
- one faces a window, but is on a turntable - Seeding 2
- one is in darkness - Seeding 3

Seedling 1:

Positive Phototropism

- Bends towards light.

Seedling 2:

Plant grows Straight Up

- light is detected in all directions.

Seedling 3:

Etiolation

- Grows very tall, to try and reach the light

Etiolation: definition

When the *growth of a plant* is tall, fast, and spindly due to lack of light, as the plant attempts to *reach the sunlight* by growing fast.

Coleoptiles Experiment:

Coleoptile: definition

The young shoot of a grass or cereal.

Info

Mica is Impermeable to Auxin.

Mica shards are put into some coleoptiles, with a light aiming at them.

- Coleoptile 1:
  - shard in shaded side
- Coleoptile 2:
  - Shard in Light-Facing side
- Coleoptile 3:
  - shard in tip.

Coleoptile 1:

Auxin unnable to *Accumulate* as the mica *prevents* diffusion into the Shaded side.

Coleoptile 2:

Auxin *Accumulates* on shaded Side, *growth* is stimulated. Coleoptile *bends* towards the light.

Coleoptile 3:

Auxin *Accumulates* on shaded Side, *growth* is stimulated. Coleoptile *bends* towards the light.

The End