Meristems

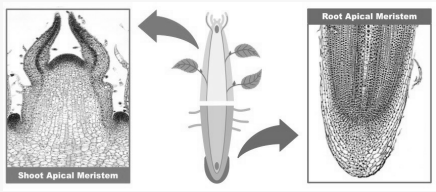
Undifferentiated cells in the meristems of plants allow indeterminate growth

Meristems are tissues in a plant consisting od undifferentiated cells capable of indeterminate growth.

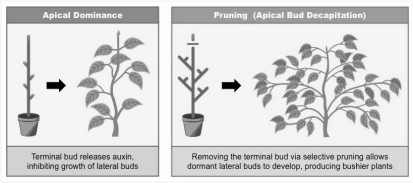
Meristems tissue can be divided into apical meristems and lateral meristems.

Apical meristems	Occur at the shoot and root tips. Responsible for primary plant growth Give rise to new leaves and flowers.
Lateral meristems	Occur at the cambium. Responsible for secondary growth. Produce bark.

Apical Growth in Roots and Shoots



The Role of Auxin in Apical Dominance



Auxin

Auxin efflux pumps can set up concentration gradients of auxin in plant tissue.

Auxin efflux pumps can set up concentration gradients within tissues - changing the distribution of auxin within the plant.
These pumps can control the direction of plant growth by determining which regions of plant tissue have high auxin levels.
Auxin efflux pumps can change position within the membrane and be activated by various factors.

Auxin has different mechanism of action in the roots of plants versus the shoot of plants.

Shoots	Auxin stimulates cell elongation, so high concentrations of auxin promote growth as cells become larger.
Roots	Auxin inhibits cell elongation, so high concentrations of auxin limits growth as cells become relatively smaller.

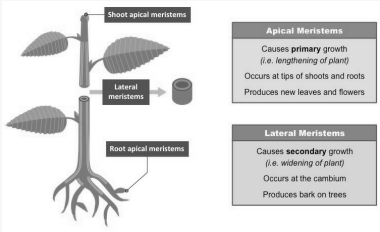
Auxin (cont)

Auxin influences cell growth rates by changing the pattern of gene expression.

Auxin is a plant hormone that influences cell growth rates by changing the pattern of gene expression with a plant's cells. Its mechanism of action is different in roots and shoots as different gene pathways are activated in each tissue.

In shoots, auxin increases the flexibility of the cell wall to promote plant growth via cell elongation.	Auxin activates a proton pump in the plasma membrane which causes the secretion of H+ ions into the cell wall.
	The resultant decrease in pH causes cellulose fibres within the cell wall to loosen (by breaking the bonds between them).
	Additionally, auxin upregulates expression of expansins, which similarly increases the elasticity of the cell wall.
	With the cell wall now more flexible, an influx of water (to be stored in the vacuole) causes the cell to increase in size.

Apical vs Lateral Meristems



Apical growth

Mitosis and cell division in the shoot apex provide cells needed for extension of the stem and development of leaves.

Growth at the tips of roots and shoots is due to a combination of cell enlargement and repeated cell division.

Differentiation of the dividing meristems produces a variety of stem tissues and structures.

In the stem, growth occurs in sections called nodes, while the remaining meristem tissue forms an inactive axillary bud.

These axillary buds have the potential to form new branching shoots.

Plant hormones control growth in the shoot apex.

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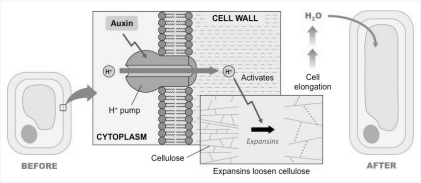
Apical growth (cont)

The growth of the stem and the formation of new nodes is controlled by plant hormones released from the shoot tip, with one of the main groups of plant hormones involves in shoot and root growth being **auxins**.

Auxins	When auxins are produced n the shoot apical meristem, it promotes growth in the shoot apex via cell elongation and devision.
	Prevents growth in lateral buds, a condiment known as **apical dominance**.
	Apical dominance ensures that a plant will use its energy to grow towards the light in order to outcompete other plants.
	As the distance between the terminal and axillary bud increases, the inhibition of the axillary bud by auxin decreases.

Mechanism of Auxin Action in Plant Shoots



Tropisms

Plant shoots respond to the environment by tropisms.

Tropisms describe the growth or turning movement of an plant in response to a directional external stimulus.

Phototropism is the growth movement in response to a unidirectional light source.

Geotropism is a growth movement in reposing to gravitational forces.

Hydrotropism is growth in response to a water gradient.

Thigmotropism is growth in response to tactile stimulus.

Both phototropism and geotropism are controlled by the distribution of auxin within the plant cells.
- in geotropism, auxin will accumulate on the lower side of the plant in response to the force of gravity.
- in phototropism, light receptors trigger the redistribution of auxin to the dark side of the plant.

Micropropagation

Micropropagation of plants using tissues from the shoot apex, nutrient agar gels and growth hormones.

Micropropagation is a technique used to produce large numbers of identical plants from a selected stock plant.

Plants can reproduce asexually from meristems because they are undifferentiated cells capable of indeterminate growth.
- when a plant cutting is sued to reproduce asexually in the native environment it is called **vegetative propagation**.
- when plant tissues are cultured in vitro to reproduce asexually, it is called **micropropagation**.

Steps of micropropagation:	1. Specific plant tissue (typically undifferentiated shoot apex) is selected from the stock plant and sterilised.
	2. The tissue sample (**explant**) is grown on a sterile nutrient agar gel.
	3. The explant is treated with growth hormones to stimulate shoot and root development.
	4. The growing shoots can be continuously divided and separated to form new samples in the multiplication phase.
	5. Once the root and shoot are developed, the cloned plant cane transferred to soil.

Use of micropropagation for rapid bulking up of new varieties, production of virus-free strains of existing varieties and propagation of orchids and other rare species.

Rapid bulking	Desirable stock plants can be cloned via micropropagation to conserve the fidelity of the selected characteristic. This process is more reliable than selective breeding because new plants are genetically identical to the stock plant. This technique is also used to rapidly produce large quantities of plants created via genetic modification.

Micropropagation (cont)	
Virus-Free Strains	Plant viruses have the potential to decimate crops, and viruses typically spread through infected plants via the vascular tissue - which meristems do not contain. Propagating plants from the non-infected meristems allows fro the rapid reproduction of virus-free plant strains.
Propagation of rare species	Microprogagation is commonly used to increase numbers of rare or endangered plant species. It is also used to increase numbers of species that are difficult to breed sexually. It may also be used to increase numbers of plant species that are commercially in demand.

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