

Apical Control of Shoot Branching

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What is Apical Dominance?

- The control of the apical bud (shoot tip) over the outgrowth response of axillary buds

What is Apical Dominance?

- A plant exhibiting a complete apical dominance phenotype will have one main stem with no lateral branches (e.g. sunflower, pea)



What is Apical Dominance?

- Not all plants exhibit complete apical dominance phenotypes
- Many conifers show particularly strong apical dominance, strongest of all in the family *Araucariaceae*, showing a single erect central trunk with strongly differentiated horizontal branching. Cuttings of *Araucariaceae* species taken from a side branch will not develop erect growth

Why Is Apical Dominance Important To The Plant?

- **Herbivores**
 - Smart animals often go for the nutrient rich, soft textured shoot apex
- **Environmental**
 - Damage caused by wind, trampling, etc.
- **Gardeners**
 - Pruning

Why Is Apical Dominance Important To Us?

- **Agriculture**
 - manipulate branch and flower number to optimize seed/fruit production
- **Horticulture**
 - multiple flowers impress neighbours
 - luscious bushes more appealing than spindly sticks
- **Forestry**
 - straight trees better for lumber



How Does Apical Dominance Work?

- **The Big Question:**

How does the shoot apex control the outgrowth of axillary buds?

How Does Apical Dominance Work?

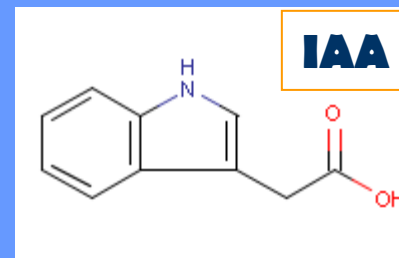
- In 1880, Charles Darwin noted that “some influence” moves from the tip of an oat coleoptile to the region below the tip, where it controls elongation
 - First evidence of a long distance signal involved in plant development

How Does Apical Dominance Work?

- Removal of the shoot apex (i.e. decapitation) releases the lateral buds from dormancy, allowing for their outgrowth

How Does Apical Dominance Work?

- **The Classical Hypothesis:**
 - The plant hormone indole-3-acetic acid (IAA), a bioactive form of auxin, is found at high levels in the shoot apex
 - Decapitation removes this “source” of IAA, as the removal of the shoot tip causes a decline in IAA throughout the plant
 - Thus, IAA may be an inhibitor of bud outgrowth; removal of its inhibition releases axillary buds from dormancy



How Can We Test Apical Dominance?

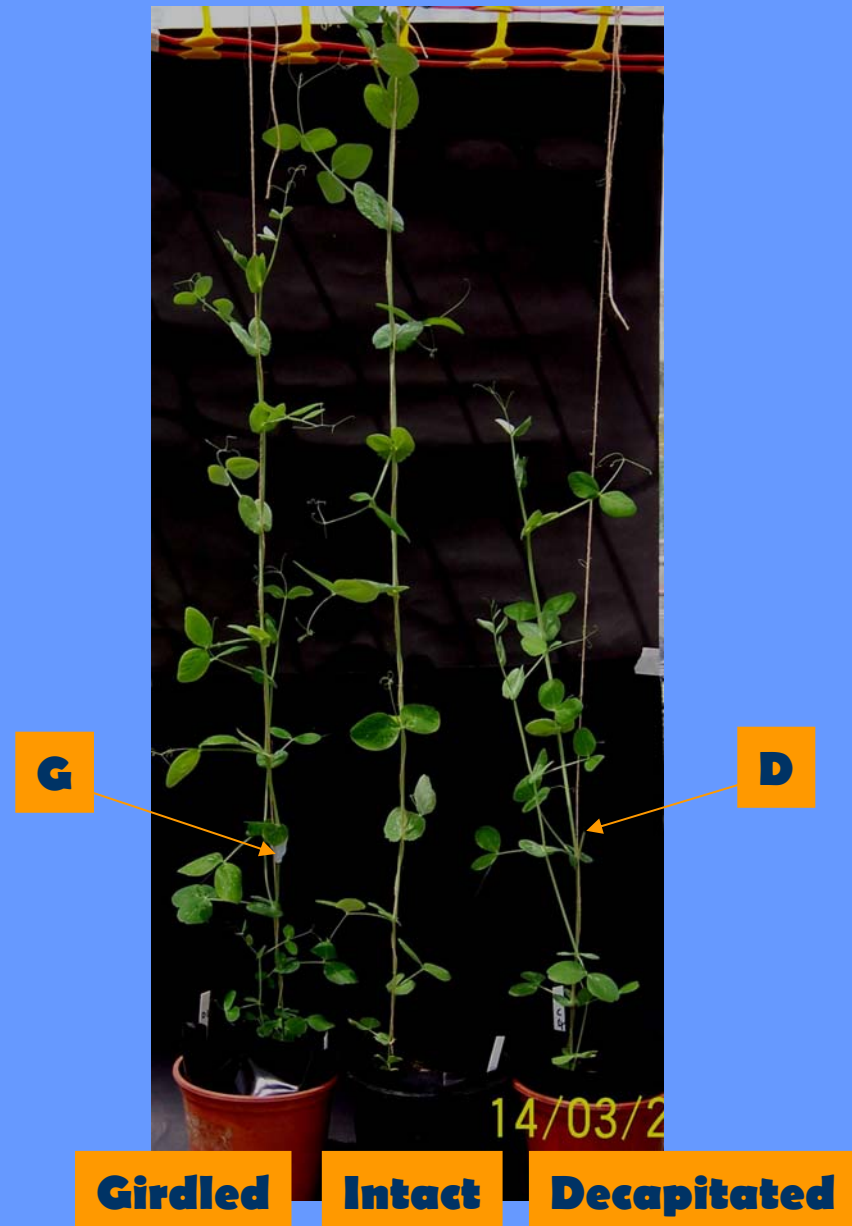
- What can we do to test the classical hypothesis and identify the underlying mechanisms of apical dominance?

How Can We Test Apical Dominance?

- Decapitation

How Can We Test Apical Dominance?

- Stem Girdling



How Can We Test Apical Dominance?

- Exogenous Application
 - Candidate compounds, hormones, transport inhibitors, extracts, etc.



How Can We Test Apical Dominance?

- Growing Parameters
 - Lighting, nutrients, temperature, etc.

How Can We Test Apical Dominance?

- Mutants
 - Isolate and characterize



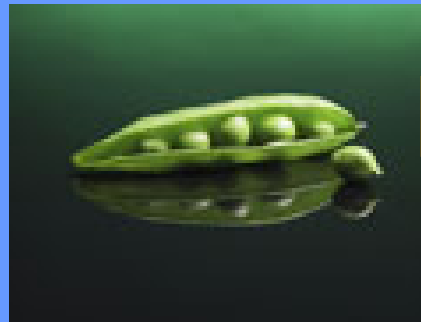
- Led to the discovery of a putative long distance signal, likely acting as an inhibitor of bud outgrowth

Where Are We Now?

- 126 years since Darwin and we still don't know
 - Classical hypothesis
 - IAA has a direct role
 - IAA transport hypothesis
 - The movement, as opposed to the level, of IAA
 - Bud transition hypothesis
 - Buds exhibit varying degrees of responsiveness
 - Novel hypotheses?

Where Are We Now?

- Why don't we know
 - Multiple mechanisms for an imperative process
 - Variations within species studied
 - Different experimental approaches and interpretations
 - Novel signals yet to be identified



Where Are We Now?

- **Future Direction**
 - Identify genes and signalling elements
 - Combine molecular and physiological approaches
 - Assess a variety of species grown under an array of conditions/parameters