

Regulating Growth and Development:  
The Plant Hormones  
Chapter 27

Plant Hormones

- definition
- model from mammals
- differences with plants
- functions
- “Classic Five” plant hormones
  - auxins
  - cytokinins
  - ethylene
  - abscisic acid
  - gibberellins
- additional chemical signals
  - brassinosteroids
  - salicylic acid
  - jasmonates
  - polyamines
  - systemin
  - nitric oxide

Auxins

- first plant hormone discovered
  - Charles and Francis Darwin, 1991
  - isolated in 1926 by Went
- Indoleacetic acid (IAA)
  - synthesized primarily in
    - shoot apical meristems
    - young leaves
    - developing fruits and seeds
- only plant hormone known to be transported polarly
  - basipetal transport
- roles
  - differentiation of vascular tissue
  - induction and arrangement of leaves
  - chemical signals that communicate over long distances
  - formation of lateral and adventitious roots
  - fruit development
- synthetic auxins

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### Cytokinins

- discovered
  - 1941 in coconut milk
  - involved in cytokinesis
- synthesis
  - root apical meristems?
  - embryos
- tissues found in
  - actively dividing
  - transported via xylem from root
- roles
  - cytokinin/auxin ratio
  - delay leaf senescence

### Ethylene

- discovery
  - 1800's city streets
  - 1901: pea seedlings
- synthesis
  - all organs of higher plants
  - more in young developing leaves than fully expanded leaves
  - very high concentrations in ripe fruit
  - diffuses through intercellular spaces
- function
  - may inhibit cell expansion
    - triple response
  - may promote cell expansion
  - may cause aerenchyma formation
  - ripen fruit
  - promote abscission
  - sex expression in Cucurbitaceae

### Abscicic Acid

- discovery
  - 1949: growth inhibitor in ash and potatoes
  - 1960's: substance accelerated abscission
- ABA
- synthesis
  - almost all cells containing chloroplasts or amyloplasts

- found in every tissue and organ, including seeds
- function
  - prevents seed germination
  - root to shoot signal
  - control stomatal closure
  - regulate protein synthesis under certain conditions

#### Gibberellins

- discovery
  - GA named and isolated from fungus (*Gibberella*) in 1934 by Yabuta and Sumiki
  - isolated from plant (bean) in 1956 by MacMillan
  - more than 125 identified
  - most plants contain >10
- synthesis
  - in developing seeds: very high levels
  - in young leaves, buds, upper stems: lower levels
  - perhaps synthesized in roots?
- function
  - make dwarf mutants grow tall
  - multiple roles in breaking seed dormancy and germination
  - can cause bolting and affect fruit development

#### Molecular Basis of Hormone Action

- all plant cells within an individual genetically identical
- gene expression
  - complex molecular mechanisms
- regulate cell expansion and cell division
- signal transduction pathways
  - often studied using mutant lines of *Arabidopsis*
- second messengers mediate hormonal responses
- stomatal movement

#### Summary

- plant hormones help regulate growth
- five major groups
  - discovery
  - synthesis location/transport
  - functions/roles
- signal transduction pathways
  - second messengers