Abscisic Acid

- History
- Chemistry
- Transport
- Physiological action
History

- Discovered in Ash trees/potato tuber
- Levels declined when dormancy broken
- Growth inhibitor
- GA antagonist
Chemistry

- synthesized in chloroplast/plastids
- mevalonic acid pathway
- cis-ABA active form
- lunuluric acid in liverworts
- photochemical production from violaxanthin
- inactivated by ABA-glucoside or O₂ oxidation
Inactivation

ABA inactivation by oxidation

Oxidation

Conjugation

ABA inactivation by conjugation with monosaccharides

4′-Dihydrophaseic acid

Phaseic acid

Abscisic acid (C₁₅)

ABA-β-D-glucose ester
Transport

- xylem/phloem
- move to roots
- synthesis in root caps -- basipetal transport
- move to all parts of plant
- increases during stress
Physiological action

- Stomatal closure
- Dormancy in seeds/buds
- Precocious germination
Seed dormancy

- peak mid to late embryogenesis
- dessication tolerance
- accumulation of seed storage proteins
- inhibits precocious germination/vivipary
Five basic mechanisms of coat-imposed dormancy:

- Prevention of water uptake.
- Mechanical constraint.
- Interference with gas exchange.
- Retention of inhibitors
- Inhibitor production.
Environmental Factors Control the Release from Seed Dormancy

- Afterripening
- Chilling
- Light
Stomatal closure

- ABA weak acid
- normal conditions enters mesophyll cells
- stress causes pH to rise in xylem sap
- ABA doesn't enter mesophyll cell, ABA-
- moves to guard cells
- activates K+/ Cl- channels out of guard cell
- causes stomatal closure
- evidence/data shown on pH changes with application of ABA

![Graph showing water potential and stomatal resistance changes with ABA application](image-url)
Stomatal closure

- ABA induces increase in cytosolic Ca\(^{+2}\) concentration
- ABA reduces the size of the stomatal aperture
Light effects

• Blue light pulse opens stomata
• Addition of ABA inhibits acidification of medium
• ABA inhibits plasma membrane H⁺ - ATPase
Redistribution of ABA in Leaf

Well-watered conditions pH 6.3

Water stress pH 7.2

ABA

ABAH

ABA−

Xylem

Guard cell
Water Potential
CAM induction

Figure 4. Titratable organic acid levels in well-watered, nonstressed (control) plants, in abscisic acid treated plants to close stomata, and in water-stressed plants during the light period.
Signaling

- ABA binds to receptor
- Form Reactive oxygen species
- Activate Ca$^{+2}$ channels
- Intracellular Ca$^{+2}$ goes up, inhibit K$^{+}$ channels
- Membrane depolarization activates K$^{+}$ channels out
- Stomata close