Plant Movements

Movement Mechanisms

- Turgor Movements
  - gain and loss of cell water, resulting in change in cellular turgor pressure
  - reversible
  - example: nyctinasty (sleep movement)

- Growth Movements
  - due to unequal growth on opposites of a plant organ
  - irreversible
  - example: phototropism

- Dehydration Movements
  - as a plant part dries, it twists, splits, pops, etc.
  - irreversible
  - example: dehiscent fruits, like bean pods

Plant Movements by Response Category

Tropism
- directional response with regard to a stimulus
- positive = toward a stimulus (e.g., phototropism of stems)
- negative = away from a stimulus (e.g., gravitropism of stems)

Nastic Movement
- non-directional response to a stimulus
- example: nyctinasty

Nutation
- endogenous movement independent of external stimulus
- growth movement
- example: twining motion of the stems of climbing plants

Tropisms

Phototropism
- Stems show a positive growth movement in response to light (specifically, blue light)
- First systematic analysis: Charles and Francis Darwin
- Led to discovery of “first” plant hormone, auxin, by Fritz Went in 1926

Oat Seedling Anatomy

The Darwins
- unilateral light: coleoptile tip curves toward the light
- remove the tip, no curvature
- cover the tip with an opaque cap, no curvature
- cover the tip with a clear cap, get curvature towards the light
- cover the portion that curves with a clear sleeve, get curvature towards the light (not shown)
- cover the portion that curves with an opaque sleeve, get curvature towards the light

1926
**Fritz Went Experiment**

**Auxin**
- eventually, a chemical was isolated that produced the stem bending effect
- it was called auxin
- several chemicals produce auxin effects
- multiple effects
  - adventitious roots
  - cell enlargement
  - cell differentiation
  - parthenocarpy

**Phototropism and Auxin**
- More auxin is transported to the dark side of the stem than to the lit side.
- Extra auxin promotes more cell elongation on the dark side.
- Uneven growth leads to stem or coleoptile curvature.

**Gravitropism**
- a growth movement
- response toward (root) or away from (stem) gravity
- stronger response in primary organs than in branch roots and stems
- involves auxin transport to the lower side of the affected organ
- in roots, gravity is detected by the root cap
- Stems: auxin promotes elongation of cells on the lower side, causing the stem to curve upward
- Roots: auxin inhibits elongation of cells on the lower side, causing the root to curve downward

**Peanut Pods:**

**Gravitropism + Circumnutation**
- peanuts bury their seed pods (fruits) underground
- the flower stalk bends downward after fertilization (gravitropism)
- the young fruit has a pointed tip
- the fruit rocks back and forth as it works its way underground (circumnutation)
- the Darwins timed a peanut that buried itself in 6 hrs

"Any one who will observe a flower-head burying itself, will be convinced that the rocking movement, due to the continued circumnutation of the peduncle, plays an important part in the act. Considering that the flower-heads are very light, that the peduncles are long, thin, and flexible, and that they arise from flexible branches, it is incredible that an object as blunt as one of these flower-heads could penetrate the ground by means of the growing force of the peduncle, unless it were aided by the rocking movement."

**Thigmotropism**
- a growth movement in response to touch
- seen in tendrils
- Auxin is transported to the untouched side, causing those cells to elongate faster than cells on the touched side.
- get tendril curvature around a support

"When an unattached tendril contracts spirally, the spire always runs in the same direction
from tip to base. A tendril, on the other hand, which has caught a support by its extremity
... invariably becomes twisted in one part in one direction, and in another part in the
opposite direction; the oppositely turned spires being separated by a short straight
portion.”

Heliotropism
• often called solar tracking
• turgor movement; reversible
• involved gain and loss of turgor pressure by motor cells at the base of leaves, flowers
• a tropic movement in response to the position of the sun

positive heliotropism
– the flat side of the leaf blade faces the sun
– the orientation of flowers toward the sun (sunflower)

negative heliotropism
– sun avoidance
– the edge of the leaf blade faces the sun

Skototropism
– stems of some climbing plants show a positive tropism in response to darkness
– Monstera (cheese plant)

"Walking" Plants

Carnivorous Plants
• six types of capture mechanisms among carnivorous plants
• five of the six involve plant movement
– ensnare prey
– increase efficiency of digestion and absorption
• three of the capture mechanisms use rapid plant movements
• stay tuned