PowerLecture:
Chapter 32
Plant Growth and Development
Section 32.0
How Would You Vote?

The following is the question for this chapter. See national results below.

- Should we label produce that has been treated with MCP?

Impacts, Issues: Foolish Seedlings, Gorgeous Grapes

- Hormones – signaling molecules that stimulate or inhibit gene activity

- Gibberellins are a class of plant hormones that stimulate stem lengthening

Impacts, Issues: Foolish Seedlings, Gorgeous Grapes

- Synthetic gibberellins have applications in production of grocery fruits and vegetables such as celery, grapes, and oranges

- Understanding how plants grow and develop is essential for farmers to maximize the quality of their produce

Section 32.1: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 32.1: Fast Plants Homepage

- Section 32.1: How a Corn Plant Develops

- Section 32.1:Plants: Novel Developmental Processes. Robert Goldberg. *Science,* June 10, 1988.

Control of Development

- Inheritable, internal mechanisms govern plant development

- Environmental cues turn such mechanisms on or off at different times, in different seasons

Seed Germination

- Process by which the plant embryo resumes growth after seed dispersal
- Depends upon environmental factors

- Temperature
- Soil moisture
- Oxygen levels

Splitting the Seed Coat

- Imbibition
  - Water molecules move into a seed
- As water moves in, the seed swells and the coat ruptures

A Grain of Corn

Growth of a Bean Plant
Growth of a Corn Plant

Genes Govern Development

- All cells in a plant inherit the same genes
- Positional differences and unequal cytoplasmic divisions lead to differences in metabolic output
- Activities of daughter cells begin to vary as a result of selective gene expression

Section 32.2: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 32.2: Plant Hormones Website

- Section 32.2: Botany Online—Plant Hormone Factsheets

- Section 32.2: Plant Hormones in War and Peace. Nicolas Rasmussen. *Isis,* June 2001.

- Section 32.2: Plant Growth Regulators and Their Applications. C.B. Christie et al. *Agribusiness Worldwide,* June 1989.

Hormones and Development

- Differential activation of genes governing hormones start cell lineages down different developmental pathways

- Hormones interact with other gene products and with the environment to affect growth and development

Plant Hormones

- Gibberellins
- Auxins
- Cytokinins
- Abscisic Acid
- Ethylene

Plant Hormones

Growth Regulators

- Brassinolides
- Jasmonates
- Salicylic acid
- Systemin

Gibberellin

- More than 80 forms have been isolated from plants, as well as from fungi
- In nature, gibberellin:
  - Helps seeds and buds break dormancy
  - Makes stems lengthen
  - Influences flowering
- Applied by growers to enhance stem length, control ripening

Gibberellin

Auxins

- Promote stem lengthening
- Play a role in responses to gravity and light
- Indoleacetic acid (IAA) is the most common auxin in nature
- Certain synthetic auxins are used as herbicides

Cytokinins

- Promote cell division
- Most abundant in root and shoot meristems and in maturing fruits
- In mature plants, produced in roots and transported to shoots
- Used to artificially extend the shelf life of cut flowers; delays leaf death

Ethylene

- Induces aging responses
- Unlike other plant hormones, ethylene is a gas
- Used to ripen fruits for market

Abscisic Acid (ABA)

- Causes the suspension of growth; promotes dormancy of buds and seeds
- Used to induce dormancy in plants to be shipped
- Also plays a role in drought response

Section 32.3: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 32.3: Tutorial on Seed Germination

Signal Transduction

- Pathway of cell communication in plants

Signal Transduction

Germination

- Gibberellin acts in the endosperm's aleurone, a protein-storing layer

- Transcription of the gene for amylase, which hydrolyzes starch molecules

- Sugar monomers released are transported to fuel plant growth

Barley Seed Germination

Auxin Experiment

Polar Transport of Auxin

Polar Transport of Auxin

Section 32.4: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 32.4: Plants in Motion

- Section 32.4: Plant Gravitational Biology

- Section 32.4: Time for a Plant Clinostat: Effects of Light and Gravity on Plants. David Hershey. *Science Activities,* Spring 2005.

Plant Tropisms

- Adjustment of plant growth toward or away from an environmental stimulus

- Phototropism - stimulus is light
- Gravitropism - stimulus is gravity
- Thigmotropism - stimulus is contact with an object

Gravitropism

- Roots tend to grow toward pull of gravity; shoots grow against it
- Gravitational field is sensed via position of statoliths (a type of amyloplast)
- Auxin is involved in response; causes asymmetric cell elongation

Phototropism

- Change in growth in response to light
- Controlled by the flow of auxin produced in the plant tip

Thigmotropism

- Growth in response to contact with a solid object
- Allows vines and tendrils to wrap around supports
- Cells on contact side elongate, causing stem to curl

- Auxin and ethylene may be involved

Mechanical Stress

- Stem elongation and plant growth patterns can be affected by winds or other mechanical stress
  - Trees in windswept areas tend to be stubbier than counterparts in calm areas
  - Shaking inhibited growth of tomato plants

Thigmotropism

Section 32.5: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 32.5: Tripping the Light Switch Fantastic (discovery of phytochrome). Jim De Quattro. *Agricultural Research,* Sept. 1991.

Biological Clocks

- Internal timing mechanisms
  - Trigger shifts in daily activity
  - Help induce seasonal adjustments
- Phytochrome is part of the switching mechanism
  - Blue-green plant pigment

Flowering Time

- Environmental cue is night length
- Unidentified hormone(s) are thought to be central to flowering

Section 32.6: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 32.6: The Story of Flowers

- Section 32.6: How Plants "See." Marcelo Yanovsky et al. *Natural History,* Sept. 2004.

Phytochrome and Flowering

- Long-day plants flower when night is shorter than a critical length
- Short-day plants flower when the night is longer than critical value
- When an intense red flash interrupts a long night, both respond as if it were a short night
- A short pulse of far-red light after the red flash cancels effect of the red flash

Vernalization

- Low temperature stimulation of flowering
- Seasonal responses

Section 32.7: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 32.7: Dormancy and Bonsai Trees

- Section 32.7: Trees and the Seasons (educational ecology activities). *Science Activities,* Spring 1994.

Control of Abscission

- Abscission
  - Dropping of flowers, fruits, or leaves
- What brings it about?
  - Auxin production declines
  - Cells in abscission zone produce ethylene
  - Enzymes digest cell walls that attach leaf or fruit to plant

Senescence

- Sum total of processes that lead to death of a plant or some of its parts
- Factors that influence senescence:
  - Decrease in daylight is recurring factor
  - Wounds, drought, or nutritional deficiencies can also bring it about

Dormancy

- A predictable period of metabolic inactivity
- Short days; long, cool nights trigger dormancy
  - Experiments have shown that exposure to light blocks dormancy
  - Demonstrates involvement of phytochrome

Breaking Dormancy

- Seeds and buds respond to environmental cues by resuming growth
- May require exposure to low temperatures for some interval
- Probably involves gibberellins and abscisic acid

Section 32.8: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 32.8: The Carnivorous Plant FAQ—How Can They Move?

- Section 32.8: Snap! How Can the Venus Flytrap Indulge Its Taste for Insect Flesh? Adam Summers. *Natural History,* June 2005.

Solar Tracking

- Differs from phototrophic growth in that it doesn't involve asymmetric growth

- Turgor pressure in cells causes the petiole (stalk that attaches leaf to stem) to straighten

- Plants reposition flat leaves to minimize heat absorption or maximize exposure to sunlight

Section 32.9: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 32.9: McKnight Collaborative Crop Research Program

- Section 32.9: *Chenopodium quinoa* Articles

- Section 32.9: Biodiversity Good Enough to Eat. Andre Carothers. *E,* Aug. 1994.

- Section 32.9: The Last Harvest (problems at the national seed bank). Paul Raeburn. *Popular Science,* May 1996.

Impacts on Human Lives

- Knowledge of plant physiology and behavior is relevant to farming practices

- Alejandro Bonifacio is an agriculturalist whose interest is quinoa, an extremely nutritious plant with the potential to feed millions in Bolivia and Peru, the most impoverished countries of Latin America

Alejandro Bonifacio

Protecting Crops

- Herbicides
- Insecticides
- Fungicides
- Can kill or sicken nontarget organisms
- Pests can develop resistance