

# Chapter 36

## Overview of plant behavioral responses

- Behavior is a response of an organism to an internal or external stimulus
- types of plant behavior
  - movement
    - bending, twisting, or rotating
      - nutation
    - rapid movement as in sensitive plants
      - response to touch
  - growth
  - seed germination
  - seasonal production of reproductive structures
  - defensive responses to attacks
    - thorns, spines, chemicals

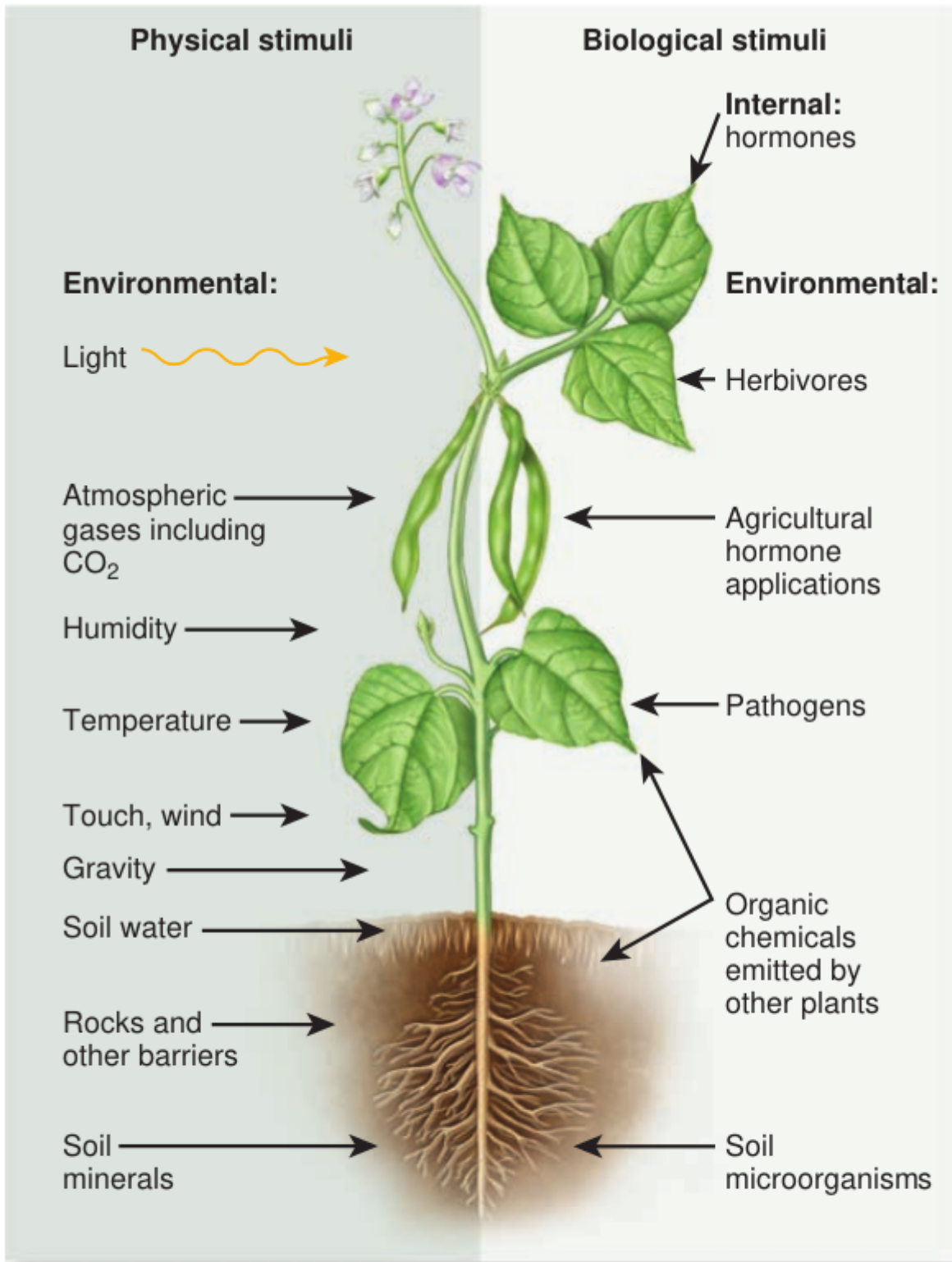
## Responses to internal and external stimuli

### Internal

- Internal biological clock
  - circadian rhythms
- chemical signals
  - transcription factors and other proteins or hormones
  - often interact with each other and external signals

### External

- light atmospheric gases (CO<sub>2</sub> and water vapor) temperature, touch, wind, gravity, water, rocks, and soil minerals
- Herbivores, pathogens, organic chemicals from neighboring plants, and beneficial or harmful organisms



**Figure 36.2** Types of plant stimuli. Plants respond to both physical and biological stimuli. Stimuli may be internal to the plant or come from the environment.

## Plant Behavior

Involves internal and external stimuli

- tropism
  - growth response that is dependent on a stimuli that occurs in a particular direction
- Reception molecules
  - located in plant cells
  - sense stimuli and cause response

## Phototropism

- Growth response to light
- light causes movement of hormone auxin away from said light
- result in unequal distribution of auxin
  - causing unequal cell elongation
- positive tropism

## Gravitropism

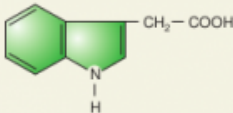
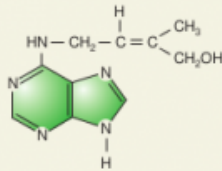
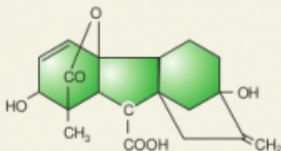
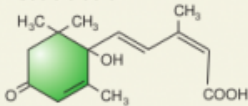
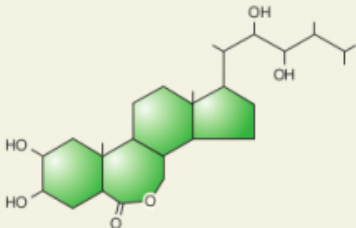
- growth response to gravity
- positive tropism
  - roots
- negative tropism
  - shoots
- columella cells in root cap/tip region sense gravity

## Thigmotropism

- Growth response to touch
- roots
  - columella cells cause roots to grow around obstacles

## Regulation of plant growth

**Table 36.1** The Major Types of Plant Hormones

Type of plant hormone	Chemical structure of an example	Functions (Note: this is a partial, not complete list)
<b>Auxins</b>	Indoleacetic acid (IAA) 	Establish apical-basal polarity, induce vascular tissue development, mediate phototropism, promote formation of adventitious roots, inhibit leaf and fruit drop, and stimulate fruit development
<b>Cytokinins</b>	Zeatin 	Promote cell division, influence cell specialization and plant aging, activate secondary meristem development, promote adventitious root growth, and promote shoot development on callus
<b>Gibberellins</b>	Gibberellic acid 	Stimulate cell division and cell elongation, stimulate stem elongation and flowering, and promote seed germination
<b>Ethylene</b>	Ethylene $H_2C = CH_2$	Promotes seedling growth, induces fruit ripening, plays a role in leaf and petal aging and drop, coordinates defenses against osmotic stress and pathogen attack
<b>Absciscic acid</b>	Absciscic acid 	Slows or stops metabolism during environmental stress, induces bud and seed dormancy, prevents seed germination in unfavorable conditions, and promotes stomatal closing
<b>Brassinosteroids</b>	Brassinolide 	Promote cell expansion, stimulate shoot elongation, retard leaf drop, stimulate xylem development, and promote stress responses

## Hormones

- chemical messengers that regulate plant growth
  - most transported in phloem tissue
  - all require an expenditure of energy on part of the plant (ATP) for transport
- interact with external environmental stimuli

## Hormones control

- growth
- seed germination
- flowering
- fruiting
- shedding of leaves
- color change of leaves

# Hormones of two broad categories

- growth inhibiting
  - mostly fall/winter
  - certain times of the year growth is not good
- growth promoting
  - mostly spring/summer

## Auxins

- first group of plants hormones to be described
- growth promoting
- produced in
  - shoot tips, seeds, fruits, leaves, stem
  - NOT in the roots

## Effects of auxin

### Promotes

- cell elongation
- shoot elongation
- production of wood
- fruit development

### Inhibits

- lateral bud development
- abscission (falling off) of leaves, flowers, fruits

## Cytokinins

- Originally detected in coconut "milk"
- growth promoting
- produced in
  - seed, fruits, roots

## Effects of Cytokinins

### Promotes

- cellular division
  - named derived from Cytokinesis

### Inhibits

- senescence
  - change of color due to breakdown of pigments

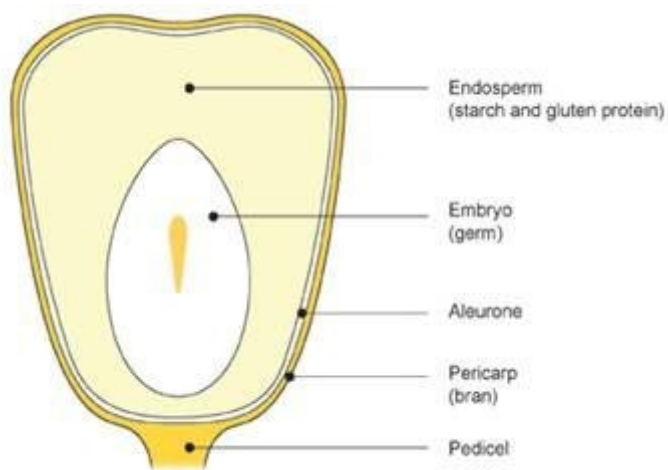
## Gibberellins (giberellic acids)

- many types
  - >200
  - more than any other group
- growth promoting
- found throughout the plant but concentrated in seeds

### Effects of Gibberellins

#### Promotes

- stem elongation by cell division and cell elongation



- intake of water causes swelling and embryo hydration
- embryo secretes gibberellins
- gibberellins transported to cells of aleurone layer to secrete enzyme
- (alpha-amylase) for breakdown of endosperm (starchy stored food) to glucose
- embryo will respire glucose to produce ATP
- embryo is directing the timing of plant germination
- Advantage seed plants

## Brassinosteroids

- growth promoting

### Effects of Brassinosteroids

#### Promotes

- cell expansion
- shoot elongation
- xylem tissue development
- stress response

## Inhibits

- leaf abscission

# Abscisic Acids (ABA)

- Growth inhibiting
- found in large quantities in seeds, mature leaves, and dormant buds

## Effects of ABA

### Promotes

- senescence
- production of storage molecules in seeds

### Inhibits

- cell elongation
- alpha-amylase production

# Ethylene

- growth inhibiting
- actually a gas produced by incomplete metabolism
- interacts with the 4 growth promoting hormones to determine cell size and shape

## Effects of Ethylene

### Promotes

- fruit ripening
- abscission of leaves, fruits, flowers

# Seed germination

- requires breaking of dormancy
  - combination of internal and external factors

## Internal

- hormones
- stored food
- H<sub>2</sub>O absorption
- embryo swelling

## External

- sunlight
- temperature
- longer day light
- soil moisture

## Generalized Seed

- Seed coat(s)
- as seed coat cracks
- Radical comes out first
  - then then shoot

## Seedling

- result of cellular reproduction and increase size
- internal development
  - cells>tissues>organs>organism

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