Plant Hormones and Plant Reproduction

Plant Responses to Internal & External Signals

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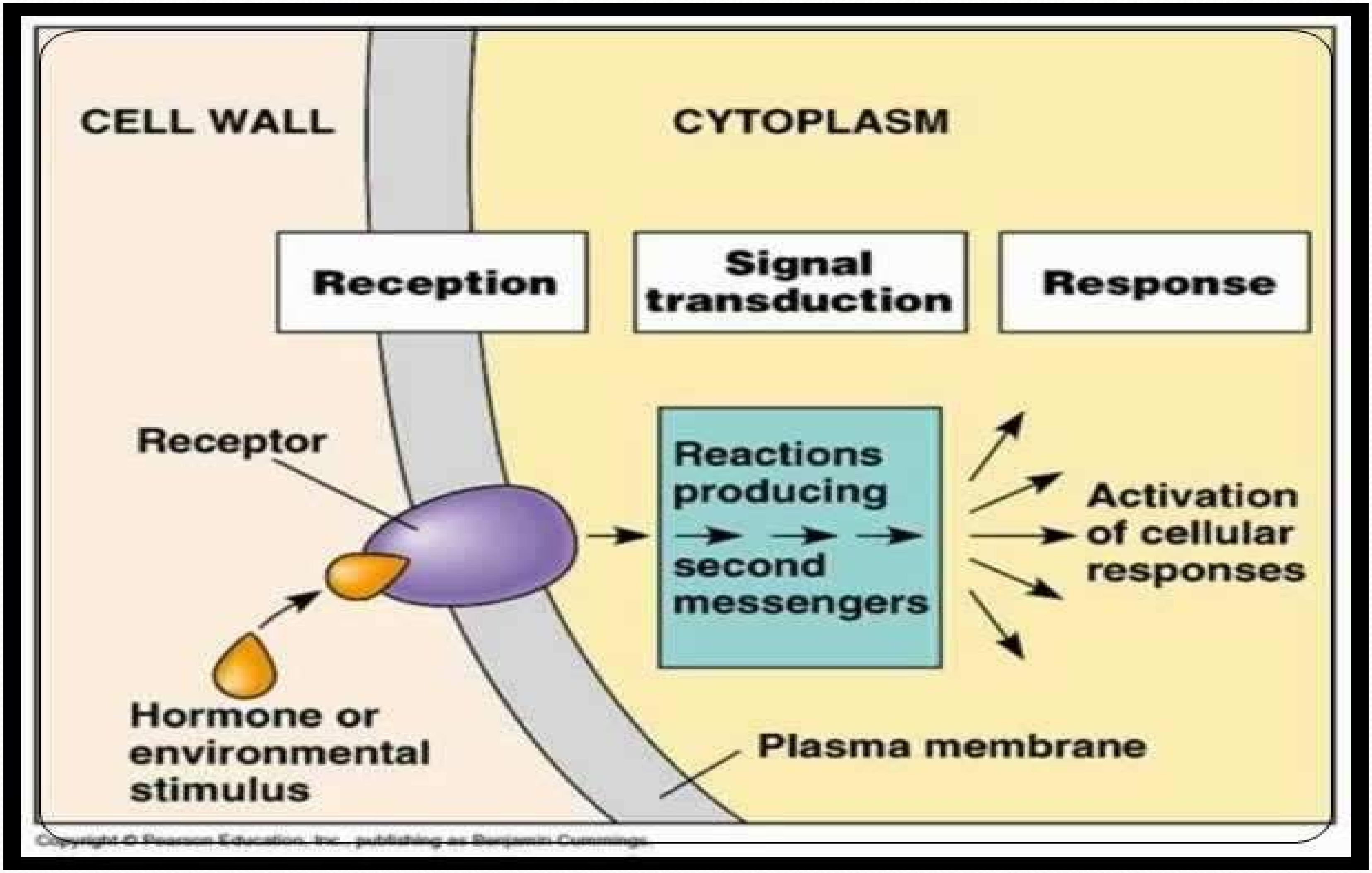
3 Steps of the Signal Transduction Pathway:

- 1. Reception—Cell signals are detected by receptors that undergo changes in shape in response to a specific stimulus.
- 2. Transduction—is a multistep pathway that amplifies the signal. This allows a small number of signal molecules to produce a large cellular response.
- 3. Response—cellular response is primarily in 1 of these ways: a) increasing or decreasing mRNA production or b) activating existing enzyme molecules.

Signal Transduction Pathway:



Plant Hormones

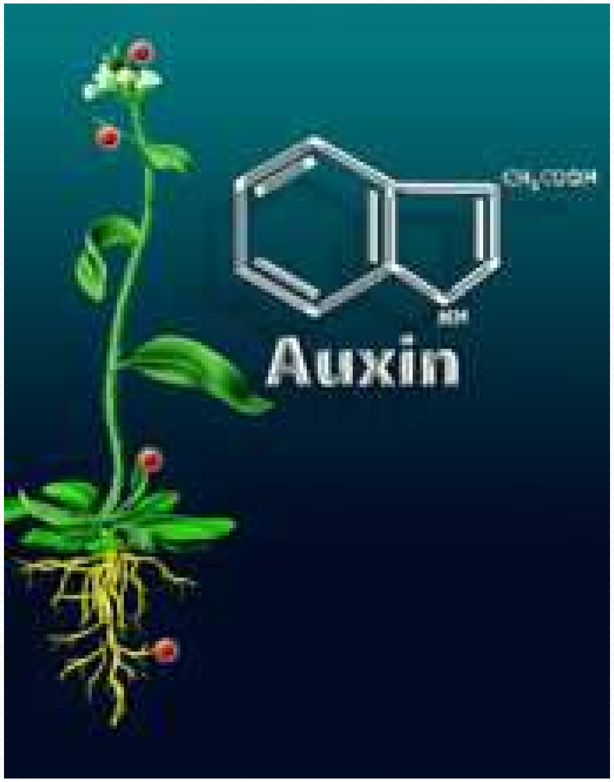
- **Hormones**—chemical messengers that coordinate the different parts of a multi-cellular organism
- Produced by one part of the body and transported to another

Tropism—a plant growth response from hormones that results in the plant either growing toward or away from the stimulus.

Plant Hormone 1: Auxin

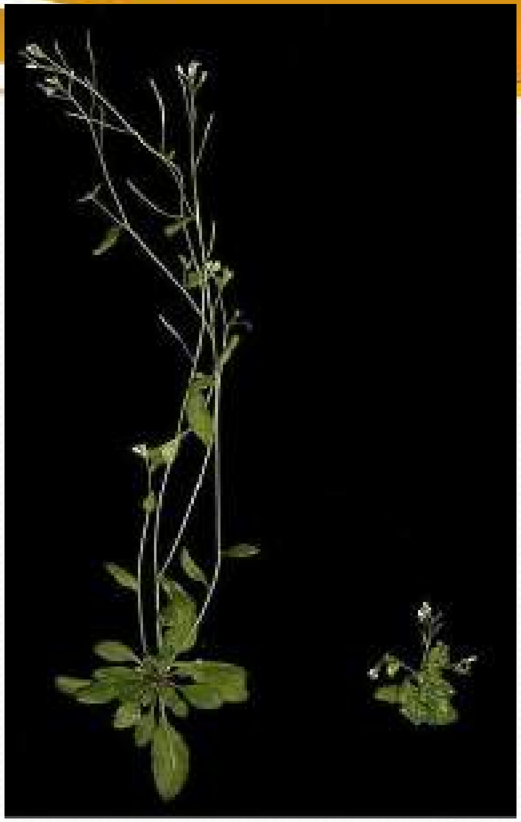
- Auxin promotes plant growth by facilitating the elongation of developing cells.

- Auxin does this by increasing the concentration of H+ in primary cell walls, which in turn, activates enzymes that loosen cellulose fibers. Cell walls become more plastic and increased turgor pressure causes the cells to expand.



Auxin

- Auxin is produced at the tips of roots and shoots.
- In concert with other hormones, auxin influences plant responses to light (phototropism) and gravity (geotropism)
- Auxin is also active in leaves, fruits and germinating seeds.

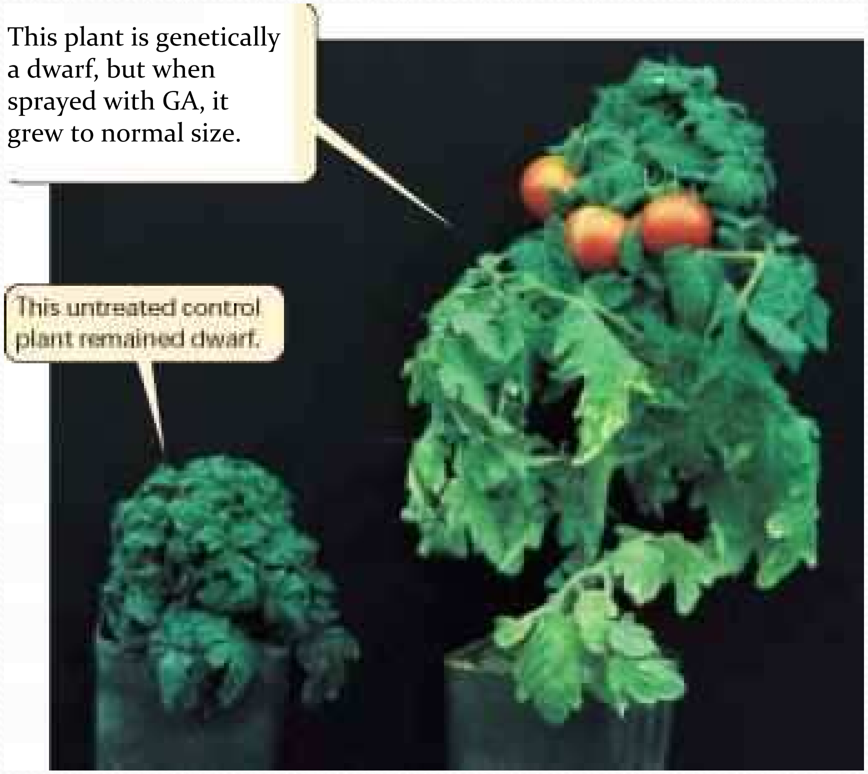


Normal Arabidosis on left,

Mutant Arabidosis on right does not produce auxin.

Plant Hormone 2: Gibberellins

- Gibberellins are a group of plant hormones that, like, auxin, promote plant growth.
- The more than 60 types of gibberellins are abbreviated GA1, GA2, etc.
- They are synthesized in young leaves, roots and shoots and transported to other parts of the plant.

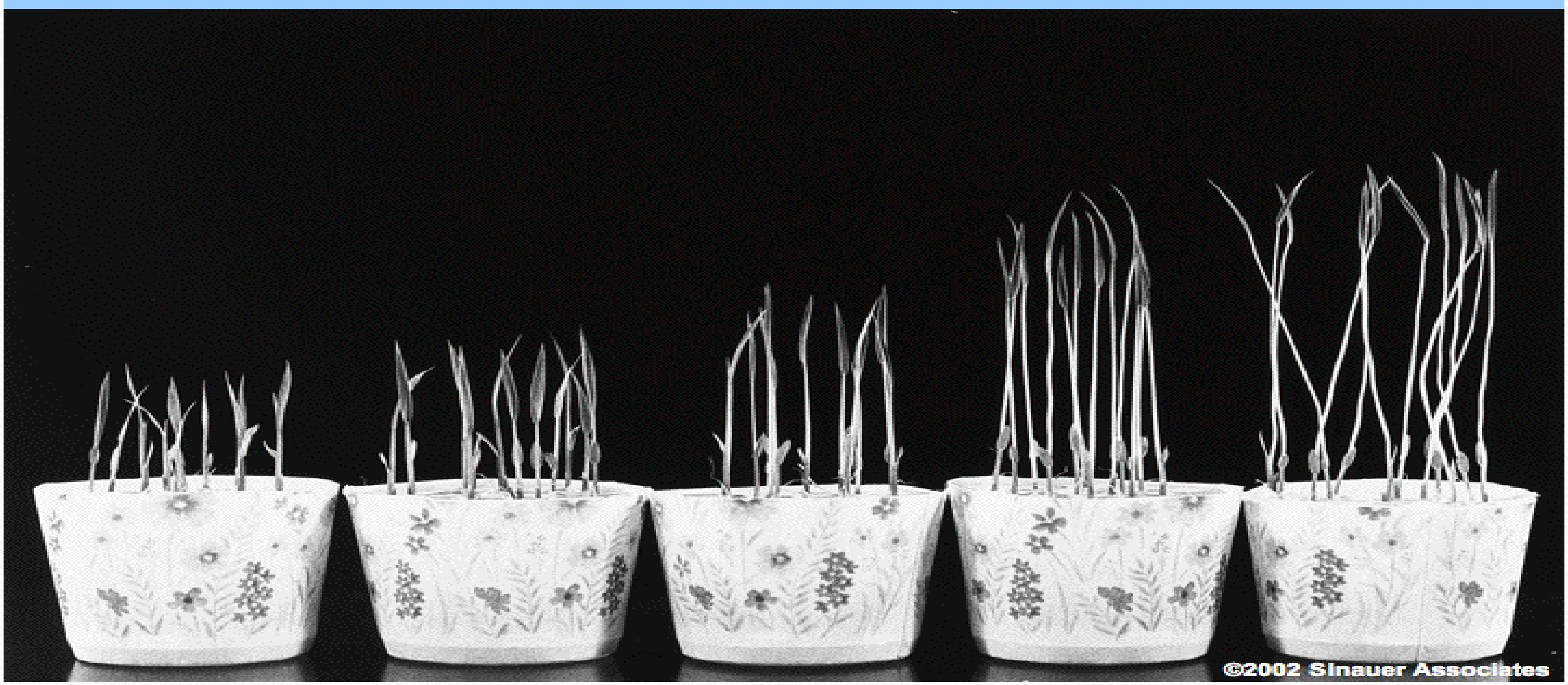


For Gibberellins, think GROWTH!

Gibberellins

- Gibberellins produced in the roots and transported to shoot tips interact with auxins to stimulate shoot growth.

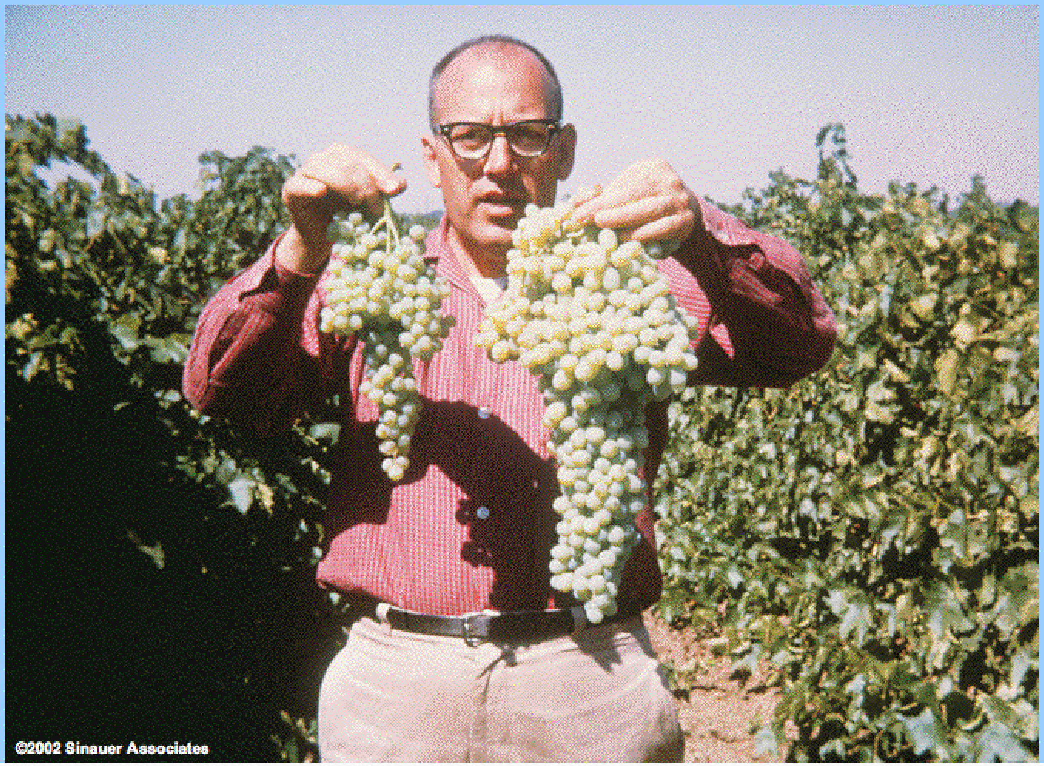
Results of increasing active GA concentration in the 'Tan-ginbozu' Dwarf Rice bioassay



Gibberellins

Gibberellins are also involved in the promotion of fruit development and of seed germination. They may be sprayed commercially on certain crops such as grapes to increase overall size of the fruit. (See right)

GA treatment allows seedless grapes to achieve normal size



Gibberellins control root growth

- Plant growth is driven by an increase in two factors: the number of cells, and their size.
- The plant hormone gibberellin controls how root cells elongate as the root grows.
- Gibberellins also regulate the number of cells in the root.

Plant roots provide the crops we eat with water, nutrients and anchorage. Understanding how roots grow and how hormones control that growth is crucial to improving crop yields

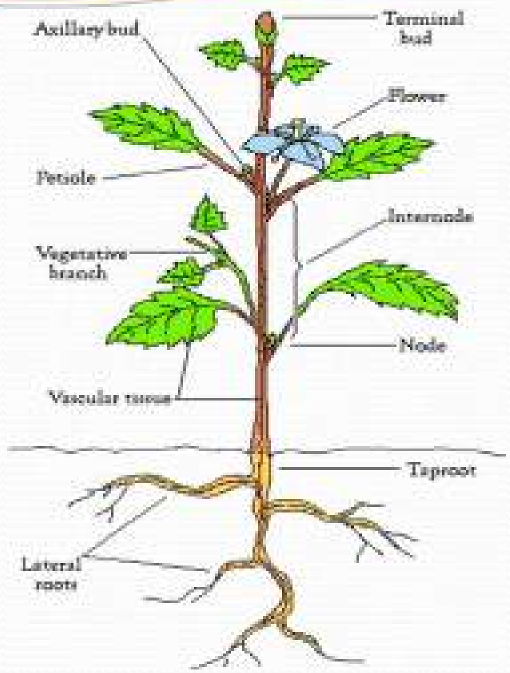
Plant Hormone 3: Cytokinins

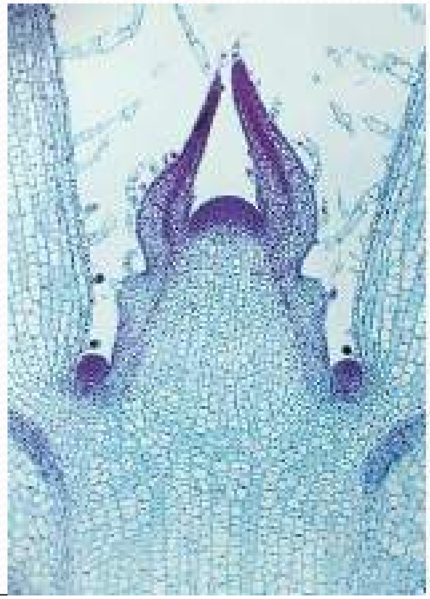
- Cytokinins are a group of hormones that stimulate cytokinesis (cell division).
- Cytokinins are produced in roots and are transported throughout the plant.
- They have a variety of effects depending on the target organ.

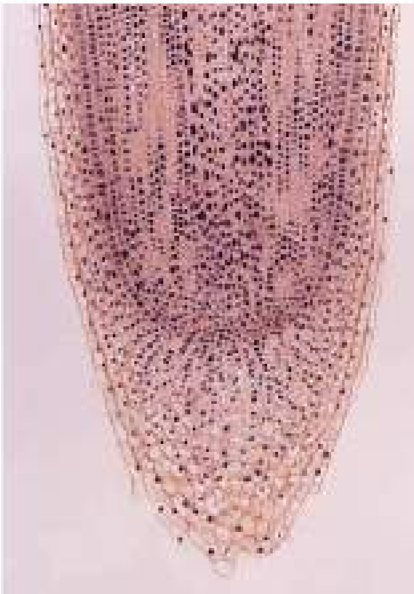
A CRE1 mutant that cannot bind cytokinins has short roots (left)

Cytokinins

- In addition to stimulating cell division, cytokinins influence the direction of organ development (organogenesis).
- For example, the relative amounts of cytokinins and auxin determine whether roots or shoots will develop.



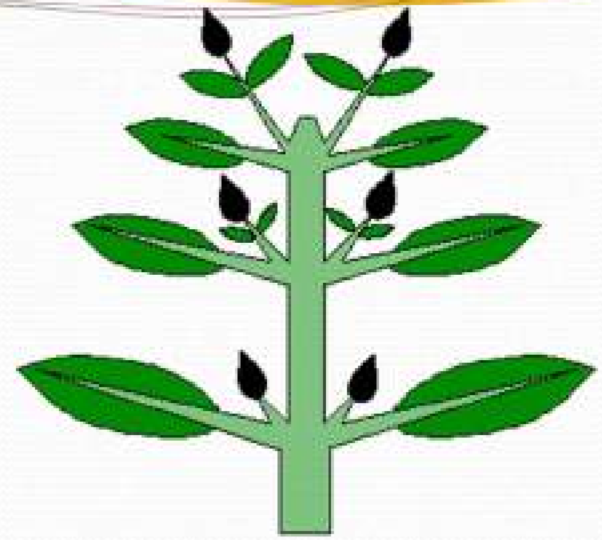


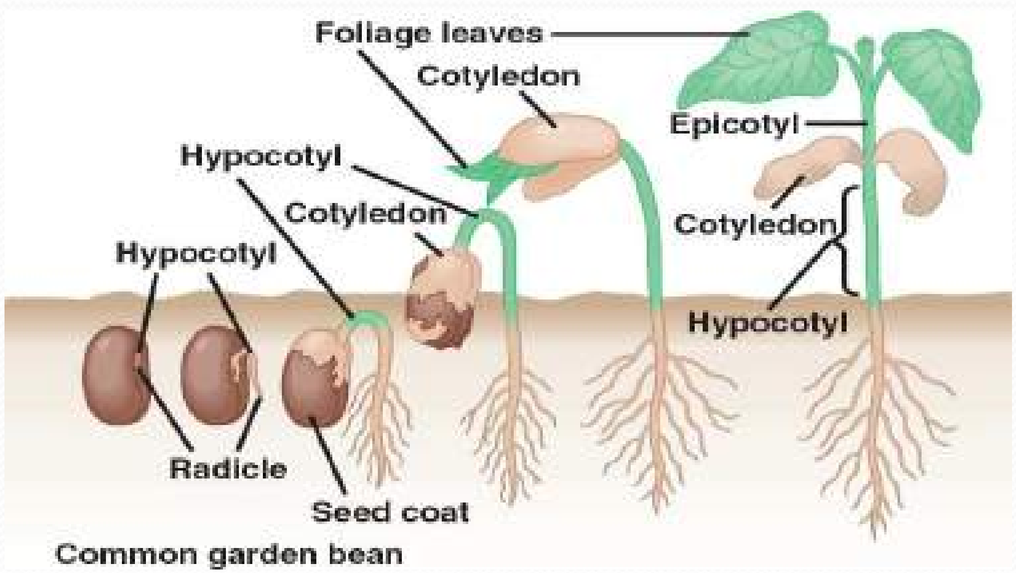


Cytokinins

- Cytokinins also modify apical dominance in stems and promote lateral bud growth.

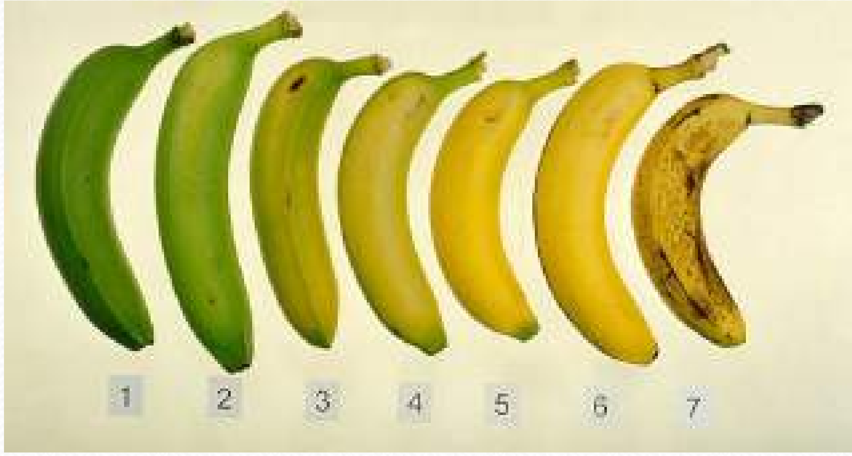
- They also stimulate seed germination.





Plant Hormone 4: Ethylene

- This is a gaseous hormone that promotes the ripening of fruit.
- During the later stages of fruit development, ethylene gas fills the intercellular air spaces within the fruit and stimulates its ripening by enzymatic breakdown of cell walls.

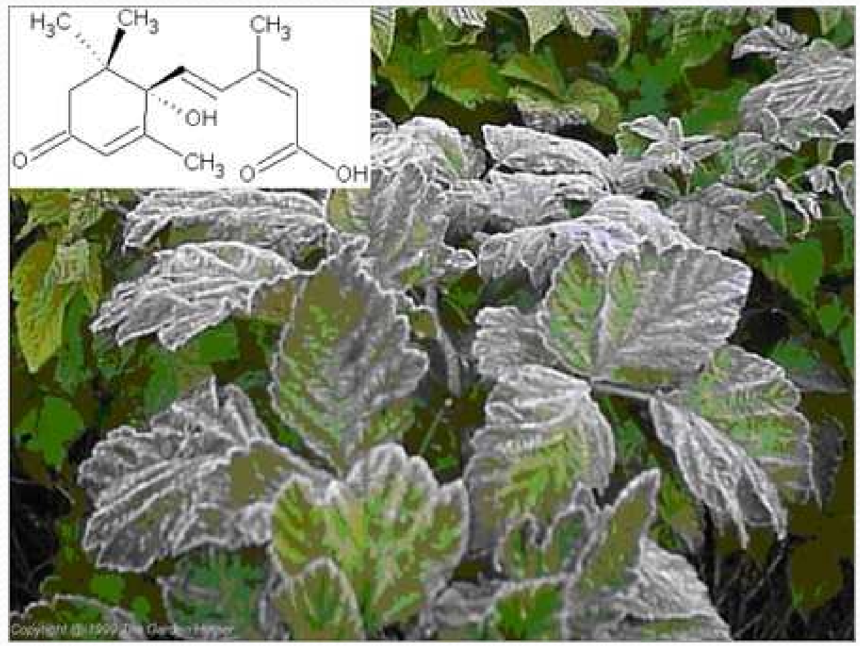


Ethylene

- Ethylene is also involved in stimulating the production of flowers.
- In addition, ethylene (in combination with auxin) inhibits the elongation of roots, stems, and leaves and influences leaf abscission (the aging and dropping of leaves).

Plant Hormone 5: Abscisic Acid

- Abscisic Acid (ABA) is a growth inhibitor.
- It promotes stomatal closing during drought stress.
- It also promotes leaf senescence (aging) when plants go dormant for the winter.



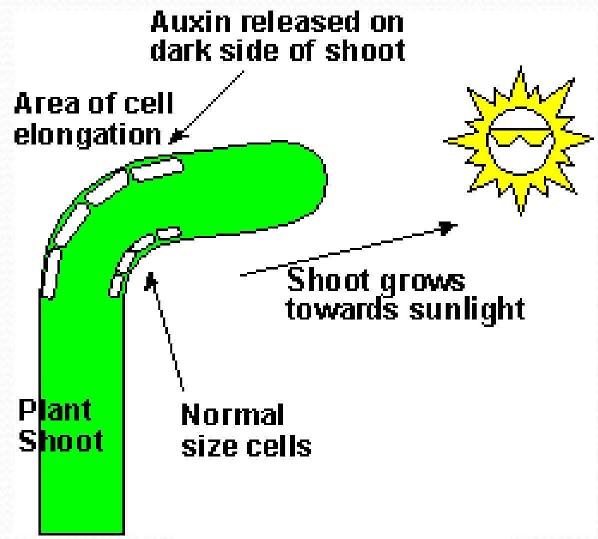
Abscisic acid (ABA)

- Abscisic acid promotes seed dormancy and inhibits early germination.
- Dormancy in these seeds is broken by an increase in gibberrelins or by other mechanisms that respond to cues such as temperature or light.

In some desert species, seed dormancy is overcome by the leaching of ABA from seeds by rains.

Phototropism

- Phototropism is a plants' response to light.
- It is achieved by the action of auxin.
- Auxin, produced in the apical meristem, moves downward by active transport into the zone of elongation and generates growth by stimulating elongation.



When all sides are equally illuminated, growth of the stem is uniform.
However, when the stem is unequally illuminated, auxin concentrates on the shady side of the stem.
This causes differential growth. The shady side grows more than the sunny side.

Gravitropism (Geotropism)

- Gravitropism is the response to gravity by stems and roots.
- Both auxin and gibberellins are involved.
- If a stem is horizontal, auxin produced at the apical meristem moves down the stem and concentrates on its lower side. Growth of the lower side is greater than that of the upper side, and the stem bends upwards.

Thigmotropism

- Thigmotropism is a response to touch.
- Example: when vines and other climbing plants contact some object, they respond by wrapping around it. The mechanism for this is not well understood.

http://www.youtube.com/watch?v=zctM_TWg5Ik

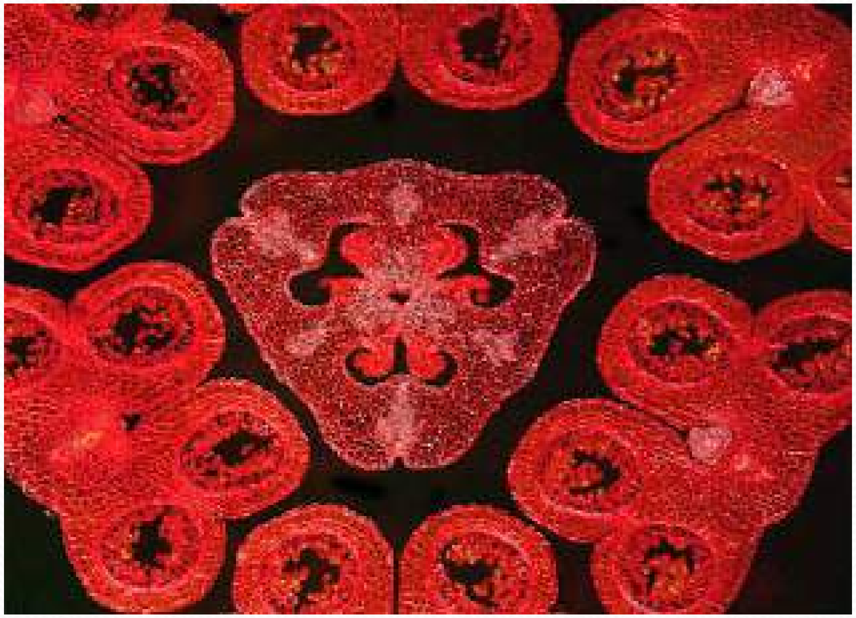
Photoperiodism

- Photoperiodism is the response of plants to changes in the photoperiod, or the relative length of daylight and night.
- To respond to changes in the photoperiod, plants maintain a circadian rhythm, a clock that measures the length of daylight and night.

Many flowering plants initiate flowering in response to changes in photoperiod. They may be long-day plants, short-day plants, or day-neutral plants. Poinsettias for example are short-day plants.

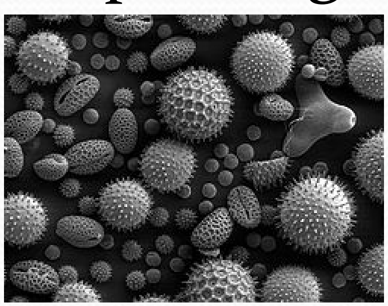
Plant Reproduction

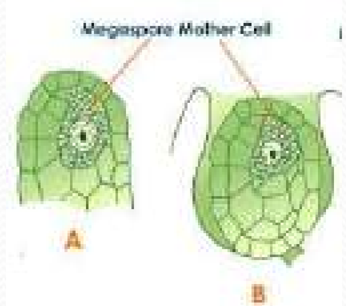
- In seed plants, such as Gymnosperms and Angiosperms, seeds are produced for reproduction.
- In addition, two kinds of spores are produced: male spores and female spores.
- Microsporangia produce microspores (male spores)
- Megasporangia produce macrospores (female spores)



Summary of Reproduction in Seed Plants:

- The microsporangium produces numerous microspore mother cells, which divide by meiosis to produce 4 haploid cells, the microspores.
- The microspores mature into pollen grains.

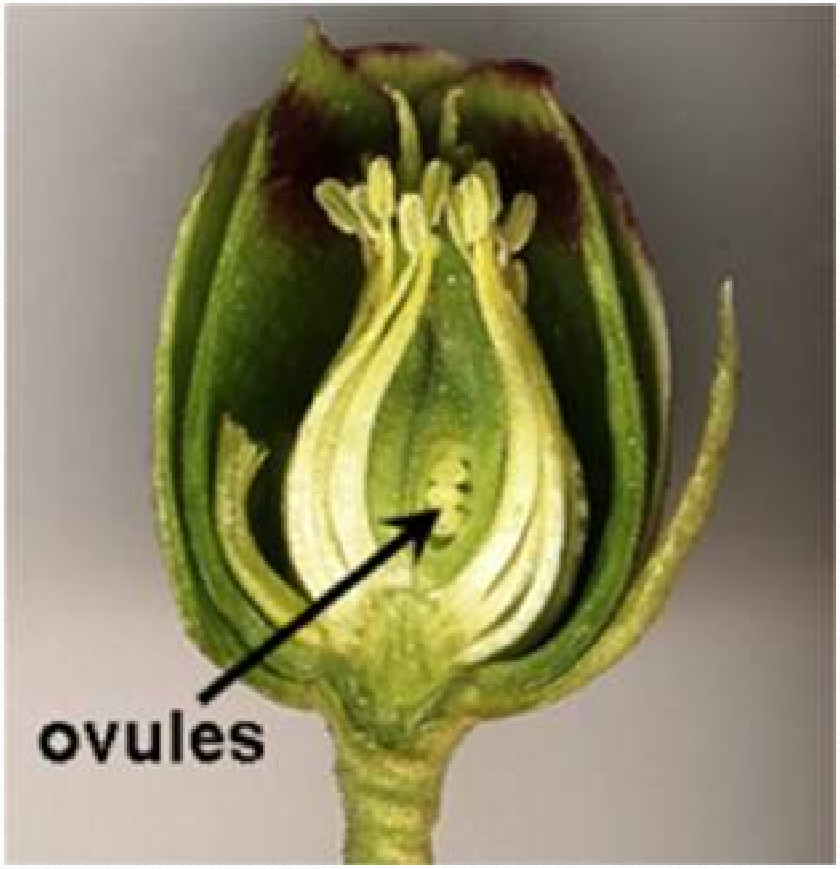




- The megasporangium, called the nucellus, produces a megaspore mother cell which divides by meiosis to produce 4 haploid cells.
- One of these survives to become the megaspore, which becomes the egg.

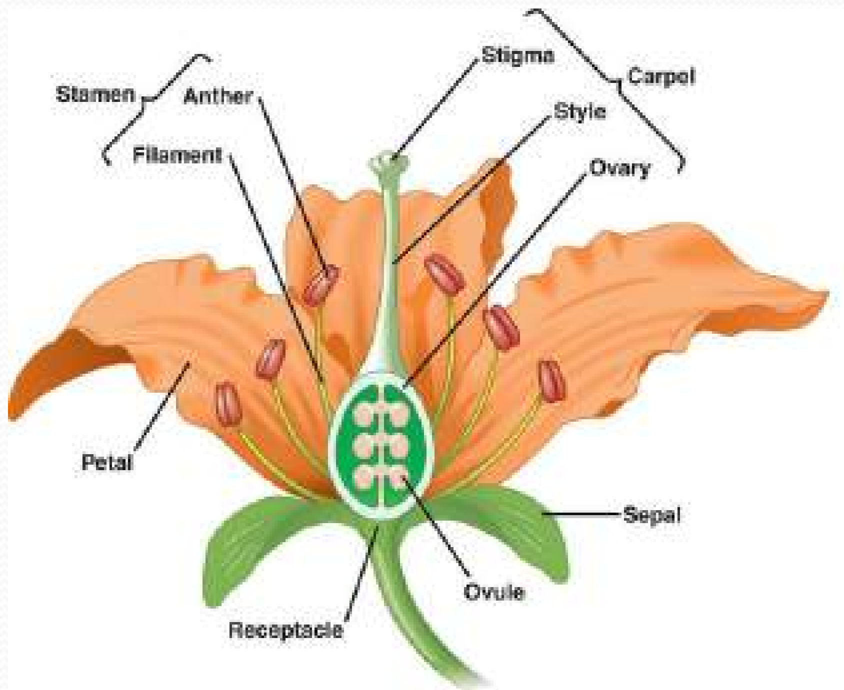
Megaspores

- The megaspore divides by mitosis to produce one egg in flowering plants (2 eggs in conifers).
- Other accessory cells may also be produced.
- One to two tissue layers called integuments surround the megasporangium.
- All of these together is called the ovule.



Angiosperm Reproduction in Detail:

- The pistil is the female reproductive structure and consists of 3 parts: an egg-bearing ovule, a style, and a stigma
- The stamen in the male reproductive structure and consists of a pollen-bearing anther and its stalk, the filament
- Petals and sepals function to attract pollinators.

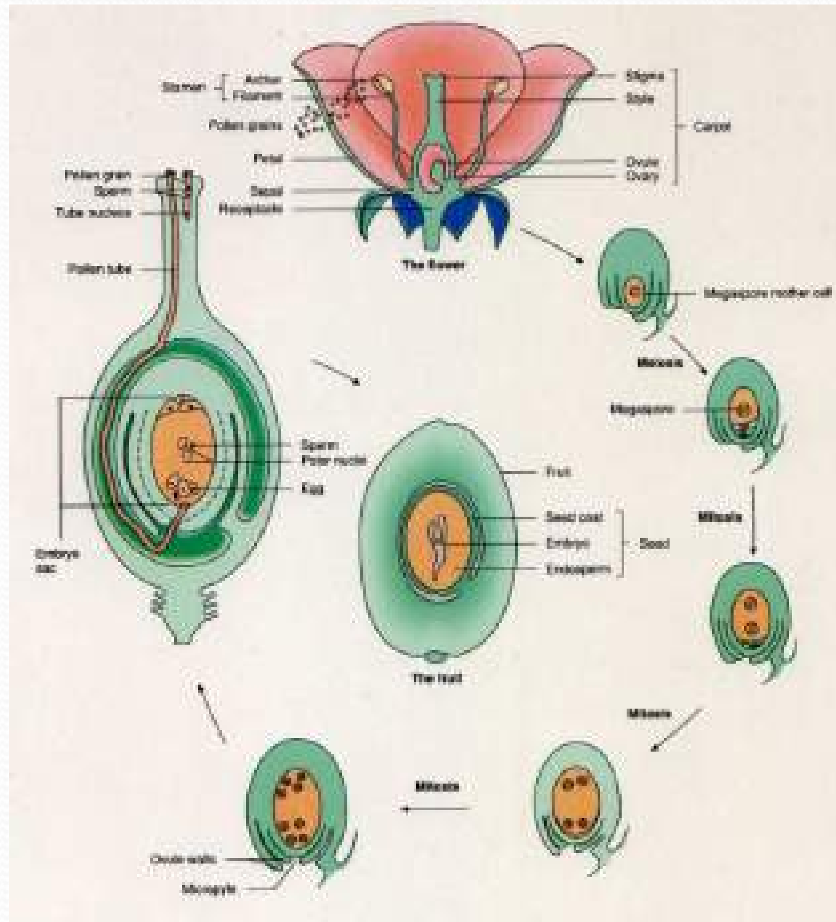


The Flower—A Major Evolutionary Advancement

- The flower attracts pollinators such as insects and birds
- The ovules are protected inside the ovary
- The ovary develops into a fruit which fosters the dispersal of seeds by wind, insects, birds, mammals, and other animals.

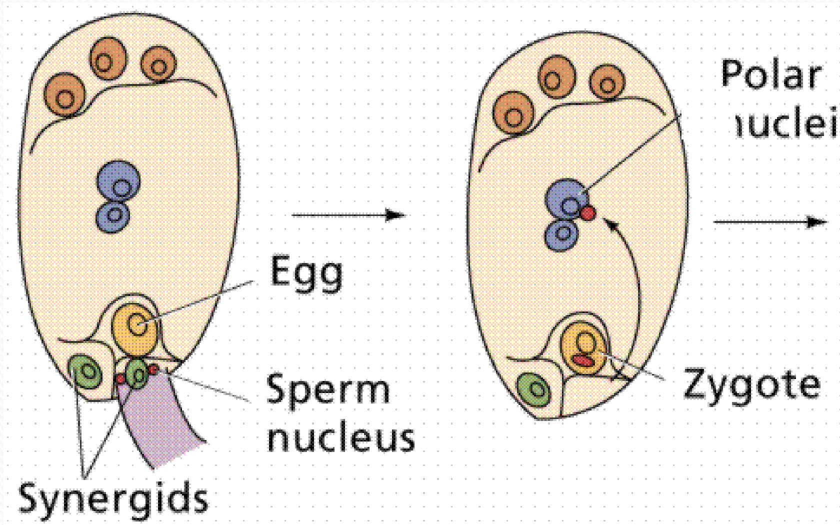
Details of Fertilization:

- The megaspore mother cell divides by meiosis to produce 4 haploid cells, the megaspores.
- One surviving megaspore divides by mitosis 3 times to produce eight nuclei. 6 of the nuclei undergo cytokinesis and form plasma membranes. The result is an embryo sac.



Embryo Sac

- At the micropyle end of the embryo sac are three cells: an egg cell and two synergids.
- At the end opposite the micropyle are three antipodal cells.
- In the middle are two haploid nuclei, the polar nuclei.



Double Fertilization

- Pollen lands on the sticky stigma.
- A pollen tube, an elongating cell grows down the style toward an ovule. There are 2 sperm cells inside the pollen tube.
- When the pollen tube enters the embryo sac, one sperm cell fertilizes the egg, forming a zygote.
- The other sperm cell fuses with both polar nuclei (the other cells produced by the megaspore) forming a triploid nucleus.
- The triploid nucleus divides by mitosis to produce the endosperm, which provides nourishment for development of the embryo.

THANK YOU