Plant Growth and Development – Purves *et al.* Chapter 37

As they grow from seed to seed, plants undergo tremendous changes of size, morphology, and anatomy. Their small embryos grow and push tiny roots and shoots out into the environment as they develop into seedlings. The seedlings continue to grow and develop new organs as the plant matures into an adult form that is capable of reproducing by producing more seeds. These processes do not occur randomly; they are guided by complex chemical communications that tell cells, tissues, and organs of the plant how to develop, when to grow, when to reproduce, and when to die. Throughout this life cycle, the plants must be able to sense and respond to their environment – such cues as light, water and mineral nutrient availability, temperature, and other environmental variables influence how a plant develops and grows. In this section, we will learn about some of the **hormones,** the chemical signals, that tell plants how to grow and develop. We will also learn about some of the environmental signals that influence growth and development by switching some hormones on and off.

I. **Plant Hormones** chemicals made in one part of the plant that move to another part of the plant where, at very low concentrations, they regulate growth and/or development.

A. Types of plant hormones: at least ten different types of chemical are known to act as hormones in plants.
   1. Many of these exert **multiple effects** on the plant, depending on the tissue and other conditions.
      a. Example: ABA (abscisic acid)
         i) closes stomata
         ii) promotes dormancy in seeds
   2. **Interactions** among different hormones often regulate development.
      a. Example: ratio of auxin to cytokinin tells *meristematic cells* (embryonic) whether they should develop into stems or roots.

B. Major types of plant hormone and some of their roles [Table 37.1]
   1. **Auxins** = promote growth
      a. stems elongate (get taller)
      b. branching is reduced (apical dominance = "Christmas tree effect")
      c. involved in phototropism (bending towards light)
   2. **Cytokinins** = promote cell division
      a. inhibit senescence (programmed death of organs *e.g.* leaves falling)
      b. promote branching
   3. **Gibberellins** = promote growth
      a. promote seed germination
      b. break dormancy
      1. (dormancy = metabolism slows or stops while conditions are unfavorable for growth, *e.g.* winter)
      c. promote stem internode elongation
   4. **Ethylene** = promotes senescence
      a. promotes fruit ripening (produced in wounded and ripe fruit)
      b. inhibits stem elongation

5. **ABA** = **abscisic acid** = stress hormone in plants
    a. promotes dormancy
    b. closes stomata when leaf water potential is low
    c. helps plants tolerate drought, high temperatures, freezing, salt stress – all environmental conditions that tend to cause cells to lose water.

C. Signal transduction = how does a cell know that a hormone has arrived?
    1. Cells respond to signals only if they can detect them and have the proper equipment needed to respond.
    2. Hormones, which are small chemicals, must bind to **receptor proteins** at the target cell.
        a. Receptors then use other chemicals to tell the rest of the cell that a hormone has arrived and how to respond.
    3. Responses usually include
        a. changing metabolism in cell
        b. changing gene expression – turning some genes on and others off so that different proteins are made.

II. Environmental Signals

A. Light is the primary environmental signal that affects plant growth and development.
    1. Length of night tells many plants when to grow, flower (reproduce), and senesce (die).
        a. More reliable cue of seasonality than temperature
    2. Color of light tells plants whether they are in sun or shade.
B. Plants use **photoreceptors** to detect light signals.
    1. Pigments (molecules that absorb light) linked to proteins.
    2. Different photoreceptors for different colors (wavelengths) of light.
        a. **phytochrome** = photoreceptor for red vs. far-red light
            i) measures length of darkness (night)
            ii) tell plants when to flower
            iii) cause many other responses!
        b. **cryptochromes** = photoreceptors for blue-light
            i) tell plants to open and close stomata
            ii) tell plants which direction to grow (phototropism)
            iii) help set biological clock for plants
            iv) similar to blue-light receptors in mammals and other animals
                i. (also involved in biological clocks for animals)