30.8A: Plant Defenses Against Herbivores

Plants defend against herbivores with mechanical wounding, barriers, secondary metabolites, and attraction of parasitoids.

LEARNING OBJECTIVES

Identify plant defense responses to herbivores

KEY TAKEAWAYS

Key Points

- Many plants have impenetrable barriers, such as bark and waxy cuticles, or adaptations, such as thorns and spines, to protect them from herbivores.
- If herbivores breach a plant’s barriers, the plant can respond with secondary metabolites, which are often toxic compounds, such as glycol cyanide, that may harm the herbivore.
- When attacked by a predator, damaged plant tissue releases jasmonate hormones that promote the release of volatile compounds, attracting parasitoids, which use, and eventually kill, the predators as host insects.

Defense Responses Against Herbivores

Herbivores, both large and small, use plants as food and actively chew them. Plants have developed a variety of strategies to discourage or kill attackers.
Mechanical Defenses

The first line of defense in plants is an intact and impenetrable barrier composed of bark and a waxy cuticle. Both protect plants against herbivores. Other adaptations against herbivores include hard shells, thorns (modified branches), and spines (modified leaves). They discourage animals by causing physical damage or by inducing rashes and allergic reactions. Some Acacia tree species have developed mutualistic relationships with ant colonies: they offer the ants shelter in their hollow thorns in exchange for the ants’ defense of the tree’s leaves.

Acacia collinsii: The large thorn-like stipules of Acacia collinsii are hollow and offer shelter for ants, which in return protect the plant against herbivores.
Modified leaves on a cactus: The spines on cactus plants are modified leaves that act as a mechanical defense against predators.

Chemical Defenses

A plant’s exterior protection can be compromised by mechanical damage, which may provide an entry point for pathogens. If the first line of defense is breached, the plant must resort to a different set of defense mechanisms, such as toxins and enzymes. Secondary metabolites are compounds that are not directly derived from photosynthesis and are not necessary for respiration or plant growth and development.

Many metabolites are toxic and can even be lethal to animals that ingest them. Some metabolites are alkaloids, which discourage predators with noxious odors (such as the volatile oils of mint and sage) or repellent tastes (like the bitterness of quinine). Other alkaloids affect herbivores by causing either excessive stimulation (caffeine is one example) or the lethargy associated with opioids. Some compounds become toxic after ingestion; for instance, glycol cyanide in the cassava root releases cyanide only upon ingestion by the herbivore. Foxgloves produce several deadly chemicals, namely cardiac and steroidal glycosides. Ingestion can cause nausea, vomiting, hallucinations, convulsions, or death.
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**Timing**

Mechanical wounding and predator attacks activate defense and protective mechanisms in the damaged tissue and elicit long-distancing signaling or activation of defense and protective mechanisms at sites farther from the injury location. Some defense reactions occur within minutes, while others may take several hours. In addition, long-distance signaling elicits a systemic response aimed at deterring predators. As tissue is damaged, jasmonates may promote the synthesis of compounds that are toxic to predators. Jasmonates also elicit the synthesis of volatile compounds that attract parasitoids: insects that spend their developing stages in or on another insect, eventually killing their host. The plant may activate abscission of injured tissue if it is damaged beyond repair.