Lec 6

Insect Ecology

Plant Defense Against Herbivory

Plant defense against herbivory

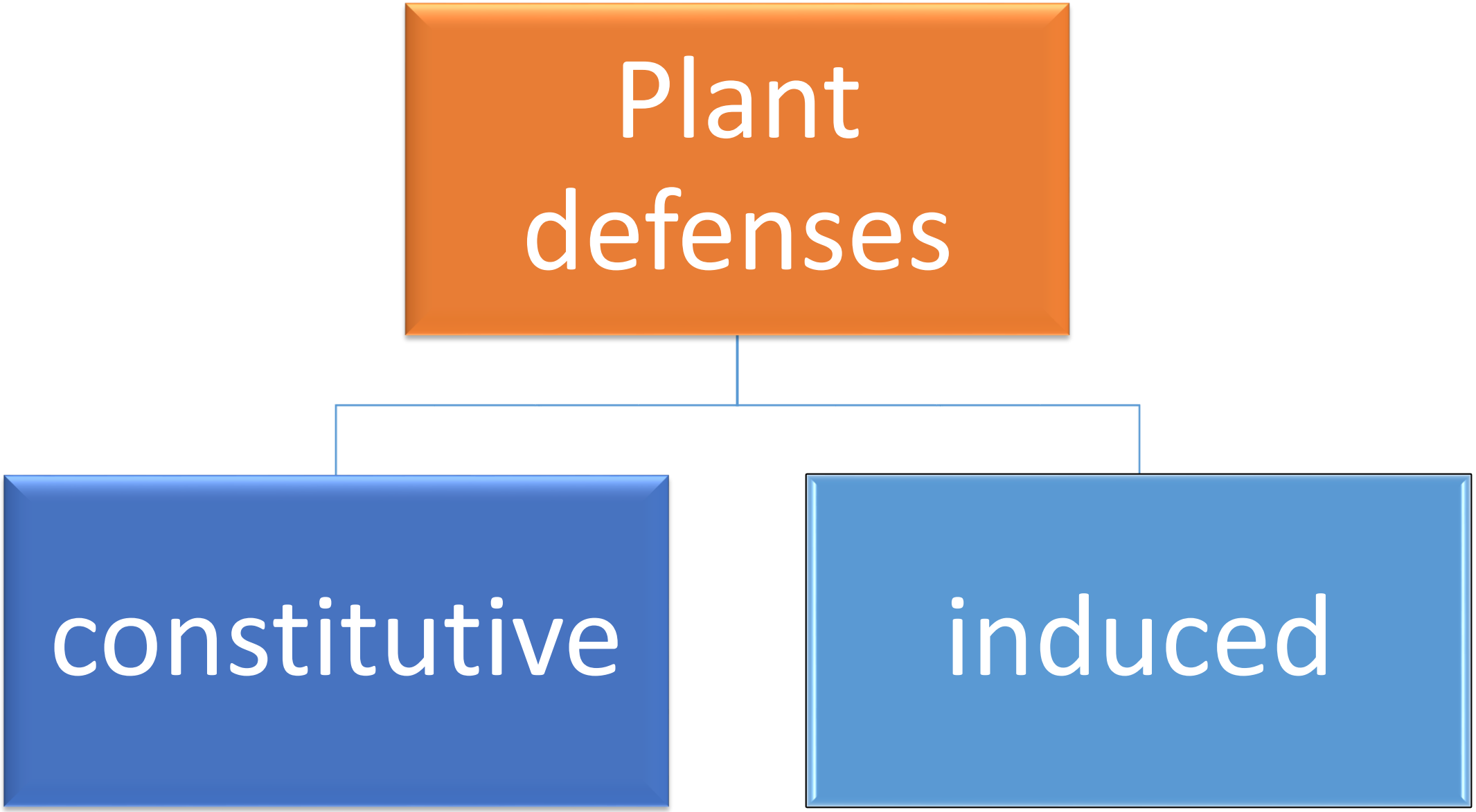
- describes a range of adaptations evolved by plants which improve their survival and reproduction by reducing the impact of herbivores.
- Plants can use several strategies to defend against damage caused by herbivores.

Strategies to defend against damage caused by herbivores

- Secondary metabolites
- Escaping or avoiding herbivores in any time and/or any place

✓Many plants produce secondary metabolites, known as allelochemicals. These chemical defenses can act as repellents or toxins to herbivores, or reduce plant digestibility.

✓Other defensive strategies used by plants include escaping or avoiding herbivores in any time and/or any place, for example by growing in a location where plants are not easily found or accessed by herbivores, or by changing seasonal growth patterns. Another approach diverts herbivores toward eating non-essential parts. Some plants encourage the presence of natural enemies of herbivores, which in turn protect the plant.


Plant defenses
constitutive
induced

- Constitutive defenses are always present in the plant, while induced defenses are produced or mobilized to the site where a plant is injured.
- Many external mechanical defenses and large quantitative defenses are constitutive, as they require large amounts of resources to produce and are difficult to mobilize.

- Induced defenses include

1. secondary metabolic products,
2. morphological and physiological changes (Mechanical defenses).

An advantage of inducible, as opposed to constitutive defenses, is that they are only produced when needed, and are therefore potentially less costly, especially when herbivory is variable

Mechanical defenses

- Structural defenses can be described as morphological or physical traits that give the plant a fitness advantage by deterring herbivores from feeding. Depending on the herbivore's physical characteristics (i.e. size and defensive armor), plant structural defenses on stems and leaves can deter, injure, or kill the grazer.

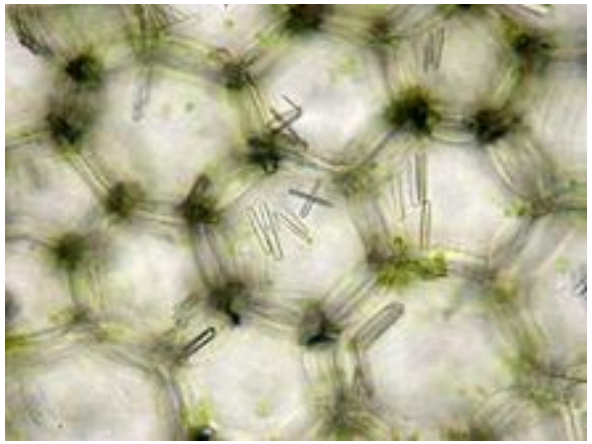
- Some defensive compounds are produced internally but are released onto the plant's surface; for example, resins, lignins, silica, and wax cover the epidermis of terrestrial plants and alter the texture of the plant tissue.

Spines and thorns

- A plant's leaves and stem may be covered with sharp prickles, spines, thorns, or trichomes- hairs on the leaf often with barbs, sometimes containing irritants or poisons.

- Plant structural features like spines and thorns reduce feeding by large ungulate herbivores (e.g. kudu, impala, and goats) by restricting the herbivores' feeding rate, or by wearing down the molars.

- Trichomes are frequently associated with lower rates of plant tissue digestion by insect herbivores.



- Raphides are sharp needles of calcium oxalate or calcium carbonate in plant tissues, making ingestion painful, damaging a herbivore's mouth and gullet and causing more efficient delivery of the plant's toxins. The structure of a plant, its branching and leaf arrangement may also be evolved to reduce herbivore impact.

Prickle

Roses actually have prickles, not thorns. Unlike thorns, prickles are actually pointed protuberances from a plant’s epidermis. Think of them as razor-sharp freckles. While they shield the plants that bear them from some depredations, certain species of planthopper, small enough to squeeze between them and slurp up sap, actually mimic their spiky appearance to avoid predators.

Spine

- Many plants have spines, but they are perhaps most memorably marshalled by the cacti. Spines not only defend the juicy stems of cacti against ravenous succulent-eaters, but also shade them from the relentless desert sun.

Trichome

Idioblast

- idioblasts are the landmines. Specialized cells that contain a variety of defensive compounds, from razor-sharp crystals to pain-inducing chemicals, idioblasts detonate when the first line of defense has been breached. The dieffenbachia, a common houseplant, contains idioblasts that fire barbed calcium oxalate crystals into the mouths of predators and then release an enzyme analogous to reptilian venom. This can cause paralysis—and thus loss of speech—hence the common name “dumb cane.”

Mutualism

- Some plants have opted to hire mercenaries. Several species of South American and African acacia tree both house and feed aggressive ants. The stinging little soldiers make their barracks inside swollen thorns and feed off of food bodies produced by the plant especially for them. The ants savagely defend their “giving trees” against all comers, be they animal, vegetable, or fungus. They even snip off the foliage of any other plants that have the nerve to encroach upon their acacia’s personal space. In experiments where the ant colonies were removed, the trees died.

Crypsis

- The sensitive plant (*Mimosa pudica*) closes its leaves when they are touched, making them appear dead and therefore unappetizing.

Chemical signaling

- Plants that are attacked by insect pests or subjected to stressful conditions such as drought or microbial infection may warn other plants of the impending crises by releasing volatile organic compounds (VOCs), which precipitate physiological reactions in nearby plants.
- They may increase concentrations of toxic compounds to ward off the enemy, or they may release compounds of their own that attract the enemy's predators.
- Some recent experiments have shown that plants also communicate through chemicals released by their roots and even via networks of fungal symbionts.

Poison

Mimicry and camouflage

- Some plants mimic the presence of insect eggs on their leaves, dissuading insect species from laying their eggs there. Because female butterflies are less likely to lay their eggs on plants that already have butterfly eggs.

Leaf shedding and color

- There have been suggestions that leaf shedding may be a response that provides protection against diseases and certain kinds of pests such as leaf miners and gall forming insects.
- Other responses such as the change of leaf colors prior to fall have also been suggested as adaptations that may help undermine the camouflage of herbivores.
- Autumn leaf color has also been suggested to act as an honest warning signal of defensive commitment towards insect pests that migrate to the trees in autumn

Importance of plant defense against herbivory to humans

1. **Agriculture**
2. **Pharmaceutical**
3. **Biological pest control**