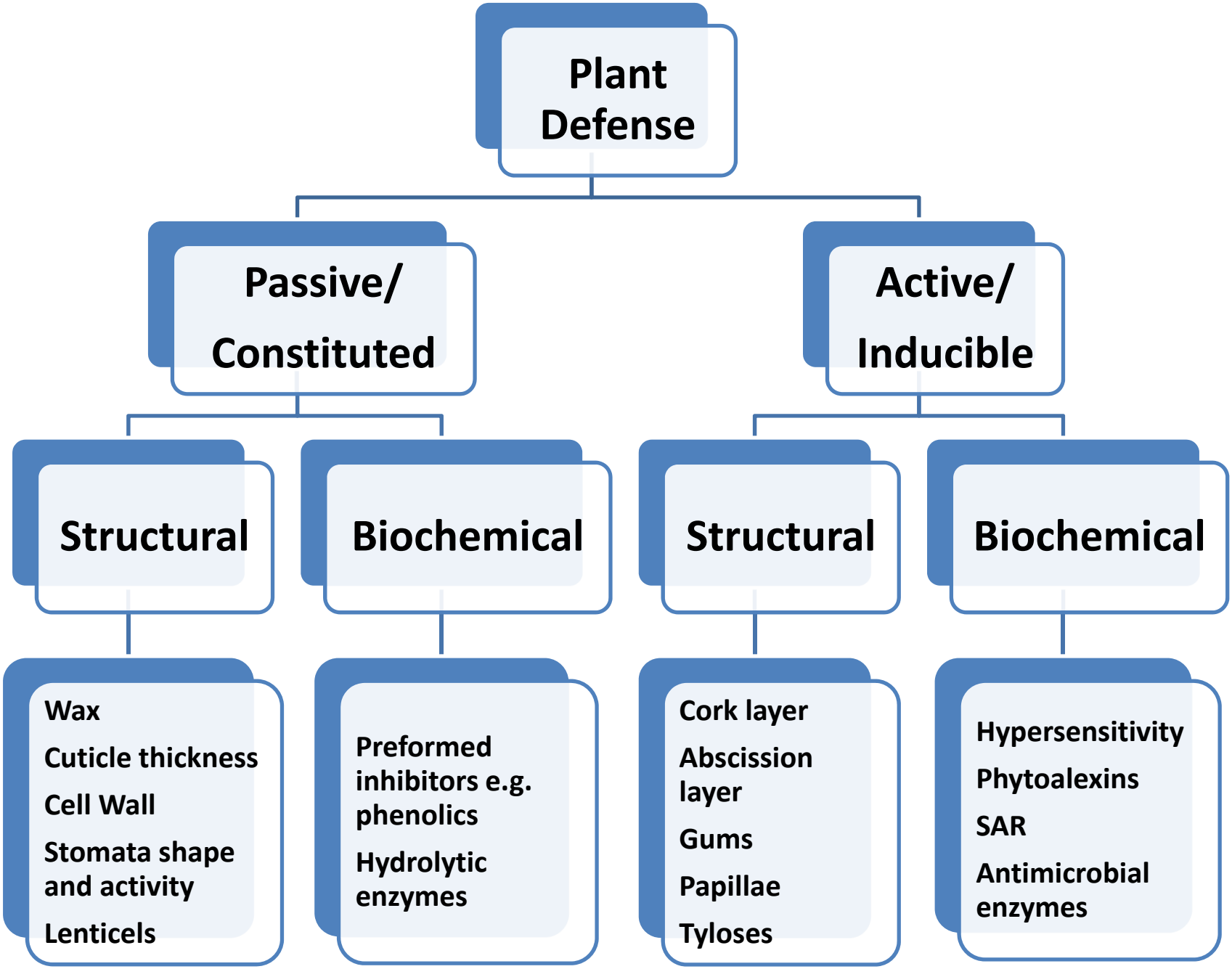
Host Resistance

- In order to protect themselves from damage, plants have developed a wide variety of constitutive and inducible defenses.
- **Constitutive** (continuous) defenses include many preformed barriers such as cell walls, waxy epidermal cuticles, and bark. These substances not only protect the plant from invasion, they also give the plant strength and rigidity.
- In addition to preformed barriers, virtually all living plant cells have the ability to detect invading pathogens and respond with **inducible** defenses including the production of toxic chemicals, pathogen-degrading enzymes, and deliberate cell suicide.


Plant Defense
Passive/ Constituted
Active/ Inducible
Structural
Biochemical
Structural
Biochemical
Wax
Cuticle thickness
Cell Wall
Stomata shape and activity
Lenticels
Preformed inhibitors e.g. phenolics
Hydrolytic enzymes
Cork layer
Abscission layer
Gums
Papillae
Tyloses
Hypersensitivity
Phytoalexins
SAR
Antimicrobial enzymes

- Pathogens that keep their host alive and feed on living plant tissue are called **biotrophs**.
- Examples of biotrophic pathogens include the powdery mildew fungus *Erysiphe pisi* and the white rust pathogen of crucifers *Albugo candida*.

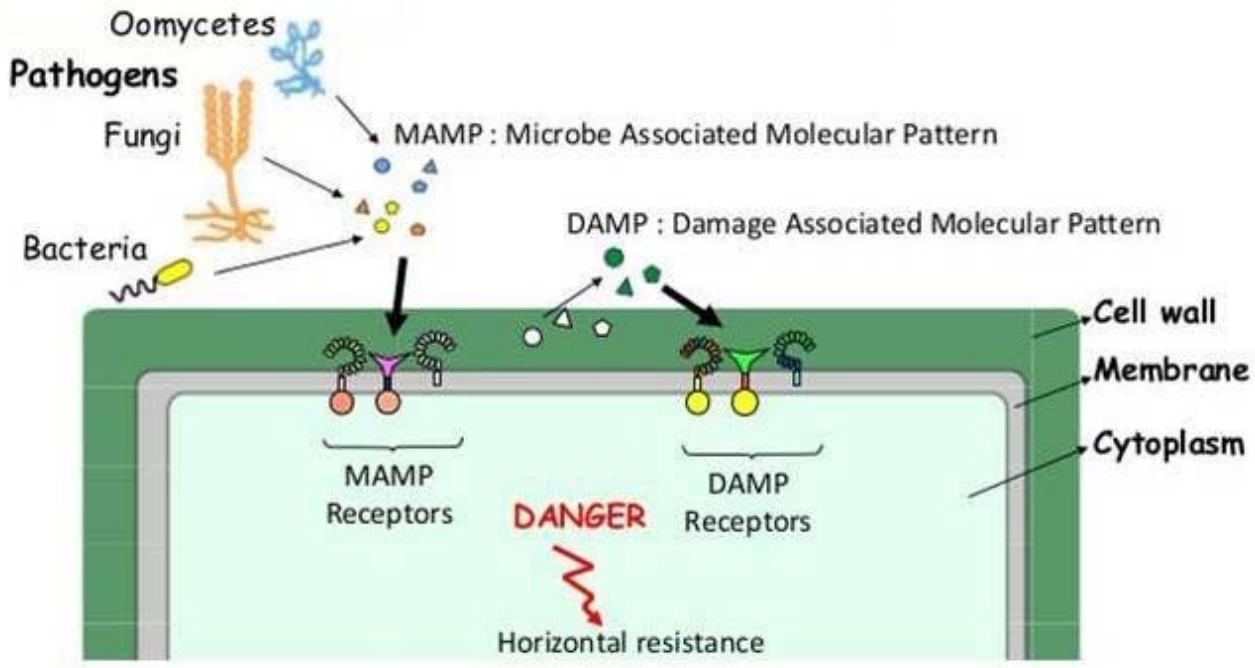
- Some pathogens often produce toxins or tissue-degrading enzymes that overwhelm plant defenses and promote the quick release of nutrients. These pathogens are called **necrotrophs**, and examples include the gray mold fungus *Botrytis cinerea* and the bacterial soft-rot pathogen *Erwinia carotovora*.
- Some pathogens are biotrophic during the early stages of infection but become necrotrophic during the latter stages of disease. These pathogens are called **hemibiotrophs** and include the fungus *Colletotrichum lindemuthianum*, the causative agent of anthracnose disease of common bean.

- When a pathogen is capable of causing disease on a particular host species, two outcomes are possible: A **compatible response** is an interaction that results in disease, while an **incompatible response** is an interaction that results in little or no disease at all.

- Although a particular plant species may be a susceptible host for a particular pathogen, some individuals may harbor genes that help recognize the presence of the pathogen and activate defenses. For example, some tomato cultivars show disease when infected with the bacterial pathogen *Pseudomonas syringae* (a compatible response), but others (cultivar Rio Grande, for example) are capable of recognizing the bacteria and limiting disease via resistance (an incompatible response). Disease resistance exists as a continuum of responses ranging from **immunity** (the complete lack of any disease symptoms) to **highly resistant** (some disease symptoms) to **highly susceptible** (significant disease symptoms).

- Plants have developed multiple layers of sophisticated surveillance mechanisms that recognize potentially dangerous pathogens and rapidly respond before those organisms have a chance to cause serious damage.
- These surveillance systems are linked to specific pre-programmed defense responses. **Basal resistance**, also called **innate immunity**, is the first line of pre-formed and inducible defenses that protect plants against entire groups of pathogens. Basal resistance can be triggered when plant cells recognize **microbe-associated molecular patterns (MAMPs)** including specific proteins, lipopolysaccharides, and cell wall components commonly found in microbes.
- The result is that living plant cells become fortified against attack. Non-pathogens as well as pathogens are capable of triggering basal resistance in plants due to the widespread presence of these molecular components in their cells.

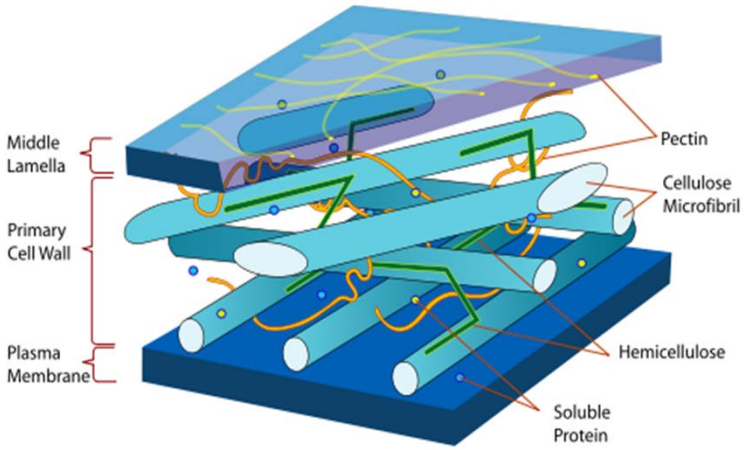
Plant immunity



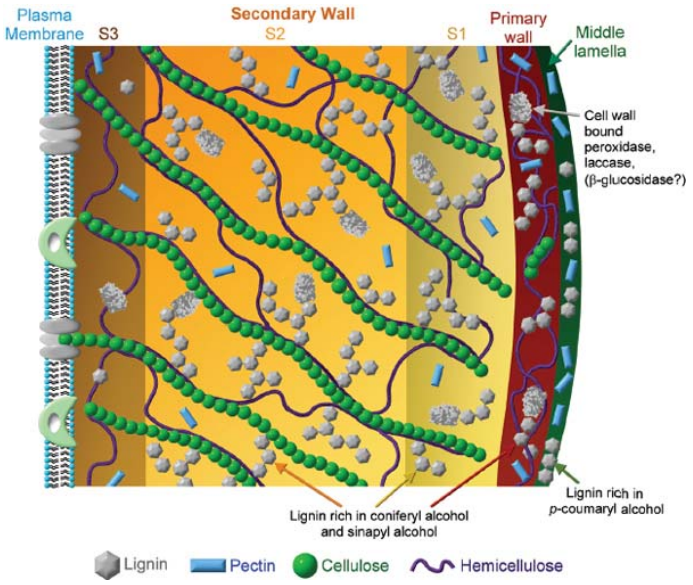
- Some pathogens are able to suppress basal resistance in certain plant species.
- Plants may respond the situation with another line of defense: the **hypersensitive response (HR)**, a deliberate plant cell suicide at the site of infection.
- HR limit pathogen access to water and nutrients by sacrificing a few cells at the site of infection.
- HR is more pathogen-specific than basal resistance and is often triggered when plant cell recognize the specific disease-causing **effector** molecules introduced into the host by the pathogen.

Structural Defenses

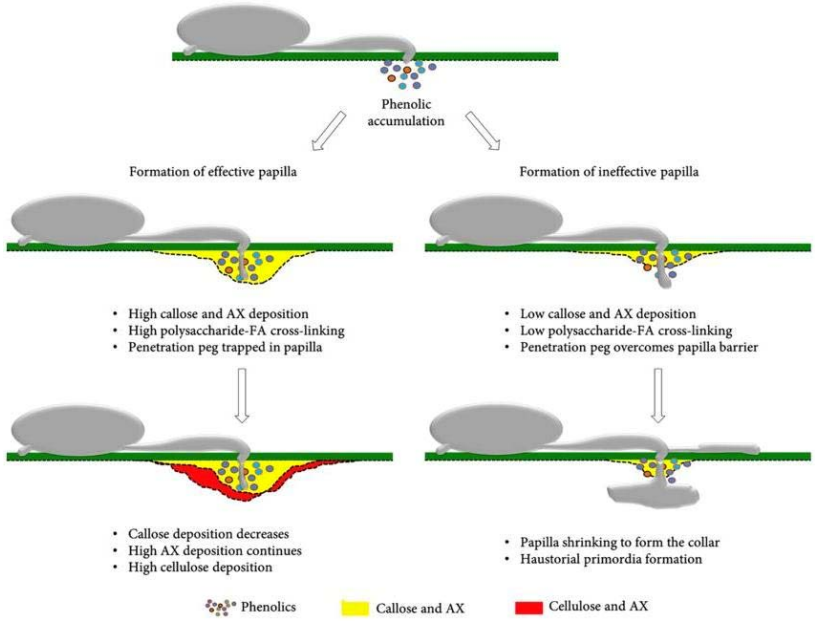
- Plant **cell wall** is a major line of defense against fungal and bacterial pathogens. It provides a structural barrier along with a wide variety of chemical defenses that rapidly activates in the presence of potential pathogens.
- The primary cell wall mostly consists **cellulose**, a complex polysaccharide of thousands of glucose monomers linked together to form long polymer chains. The cell wall may also contain two groups of branched polysaccharides: cross-linking glycans and pectins. **Cross-linking glycans** include **hemicellulose** fibers that give the wall strength via cross-linkages with cellulose.



- Many cell walls also contain **lignin**, a heterogeneous polymer composed of phenolic compounds that gives the cell rigidity. Lignin is the primary component of wood, and cell walls that become "lignified" are highly impermeable to pathogens and difficult for even small insects to chew.
- **Cutin, suberin**, and **waxes** are fatty substances that may be deposited in either primary or secondary cell walls (or both) and outer protective tissues of the plant body, including **bark**.

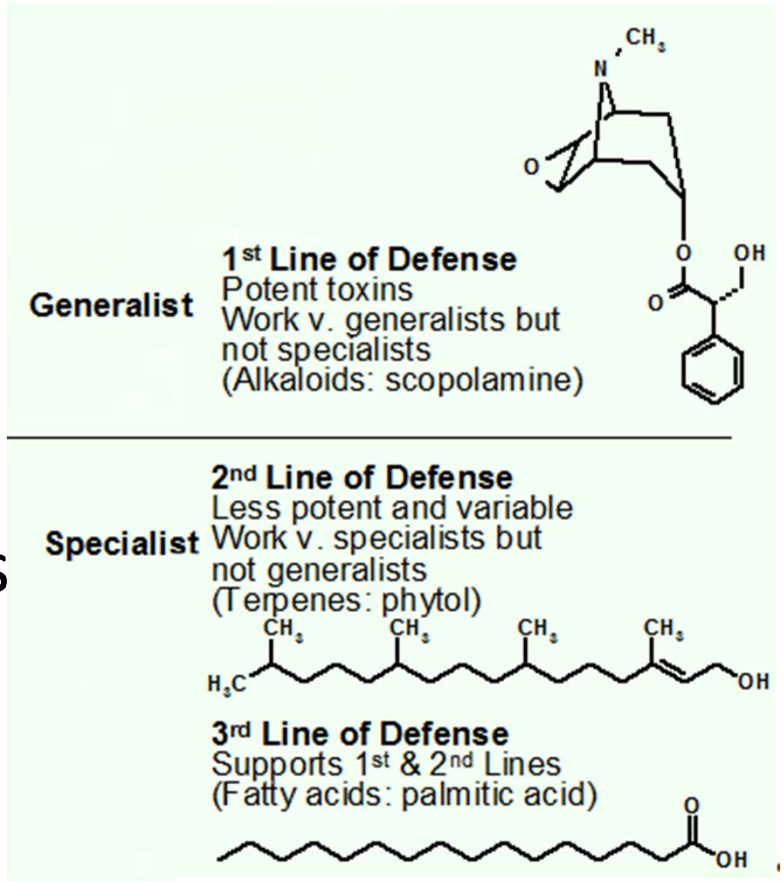


- Plant cells also respond to microbial attack by rapidly synthesizing and depositing **callose** between the cell wall and cell membrane adjacent to the invading pathogen. Callose deposits, called **papillae**, are polysaccharide polymers that impede cellular penetration at the site of infection, and these are often produced as part of the induced basal defense response.



Chemical Defense

- **Secondary metabolites** are not directly involved in growth or reproduction but they are often involved with plant defense. These compounds usually belong to one of three large chemical classes: terpenoids phenolics, and alkaloids. They protect plants against fungal or bacterial attack.



Proteins and Enzymes

- They include defensins, amylase inhibitors, lectins, and proteinase inhibitors.
- Once activated, however, defensive proteins and enzymes effectively inhibit fungi, bacteria, nematodes, and insect herbivores.

Genetics of resistance

- Resistance to disease varies among plants;
  - it may be either total (a plant is immune to a specific pathogen) or
  - partial (a plant is tolerant to a pathogen, suffering minimal injury).
- The two broad categories of resistance to plant diseases are:
  - **vertical (specific/qualitative):** A plant variety that exhibits a high degree of resistance to a single race, or strain, of a pathogen is said to be vertically resistant; this ability usually is controlled by one or a few plant genes.
  - **horizontal (nonspecific/quantitative):** Horizontal resistance, on the other hand, protects plant varieties against several strains of a pathogen, although the protection is not as complete. Horizontal resistance is more common and involves many genes.