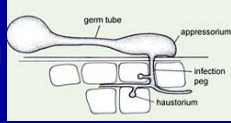


Review of Lecture 8:

Getting inside the host is a critical step in disease development

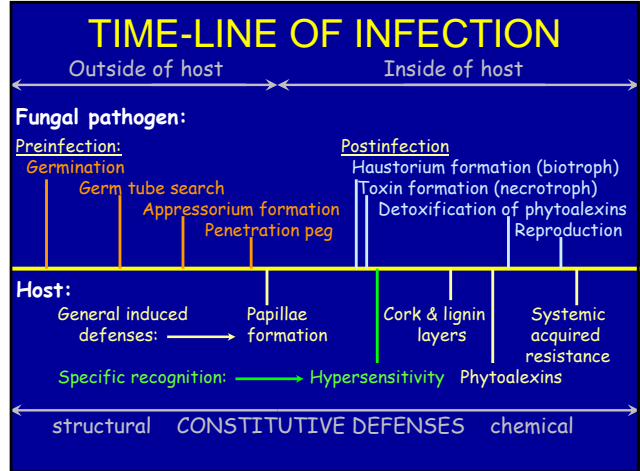


Fungal pathogens use 'contact and chemical tropisms' to guide their way to a site where infection is possible

Pathogens use several tools to establish a parasitic relationship: enzymes, growth regulators, toxins

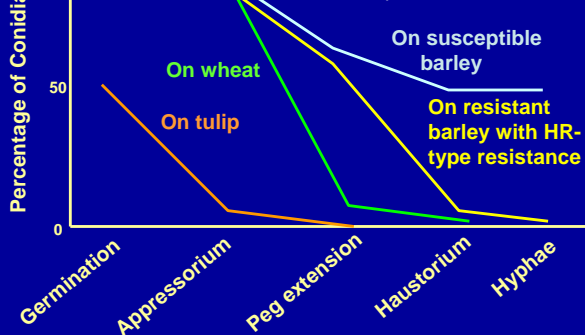
Appreciate that pathogens are highly evolved to enter and establish a parasitic relationship with their host

Use the timeline as a guide to when events relating to attack and counterattack take place

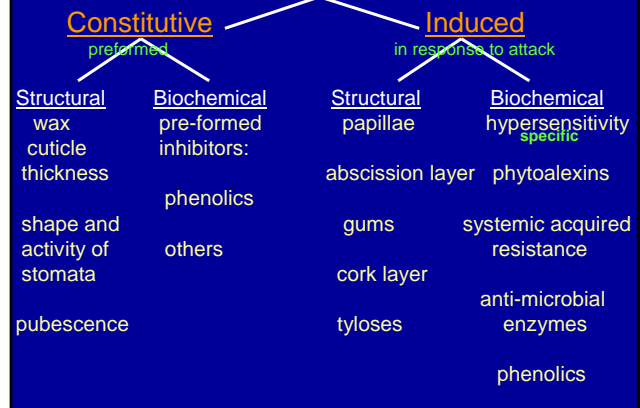


Timeline Review: Barley powdery mildew race A,

an obligate biotroph, is inoculated onto different host and nonhost plants: At what point on the timeline do the spores fail?

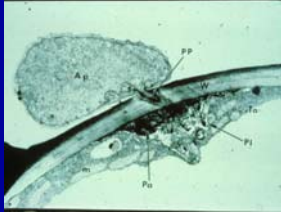


Host defenses



Induced structural defenses

Plants respond immediately to a pathogen's attempt to get inside

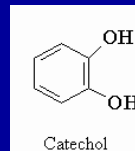
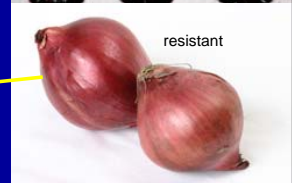


Wound plug (papillae) formation as a result of needle injury:
<http://bugs.bio.usyd.edu.au/PlantPathology/infection/movie/penetration.html>

Constitutive biochemical defense

In contrast to red and yellow onions, white onions do not contain significant quantities of certain phenolic chemicals (one is catechol). If present, these phenolics confer resistance to onion smudge disease.

Onion smudge



Phenolic compounds in plants

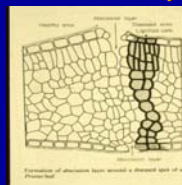


- Produced by phenylpropanoid pathway
- Considered 'secondary metabolites', but plants devote ~10-20% of fixed carbon to their synthesis
- Pigments, antioxidants, secondary structure (wood and cork), antimicrobials/antibiotics, attractants
- Compounds include flavonoids, alkaloids, phytoalexins, tannins, anthocyanins, lignin and suberin

Induced structural defenses

Abscission layer

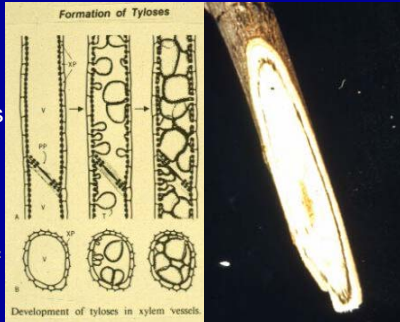
Cork layer



The formation of cork or abscission layers can limit the size of lesions, and consequently the extent of damage that can be caused by a single infection

Induced structural defenses

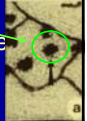
Tyloses are overgrowths of living cells that protrude via pits into xylem vessels blocking the vascular system. If they form abundantly and quickly, they can stop the spread of vascular wilt pathogens. Their formation is triggered by a 'stress condition'.



Tyloses as well as gums and resins 'compartmentalize' damaged xylem

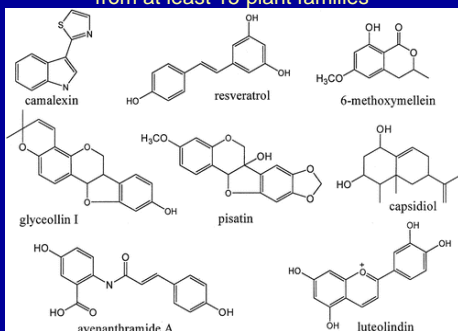
Induced biochemical defenses

- **Phytoalexins:** antimicrobial compounds synthesized after pathogen attack
- Synthesized in healthy cells **near** an infection site – i.e., **local induction**
- Synthesis occurs in all host cultivars but the rate (speed) of synthesis varies among cultivars
- Most plants produce several phytoalexins (e.g., over 20 have been isolated from potato)
- Enzymes to detoxify phytoalexins have been observed in some fungal pathogens



Phytoalexin molecules

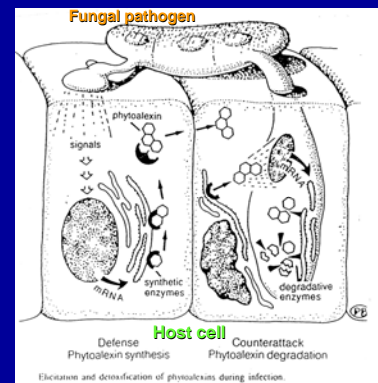
Plant produced anti-microbial compounds. Several hundred have been isolated and characterized from at least 15 plant families



Example of attack and counterattack

Phytoalexins are synthesized in response to pathogen attack

Some pathogens counterattack producing enzymes that degrade the phytoalexin



Induced biochemical defenses

- **Systemic Acquired Resistance** is the activation of defenses in distal, non-infected parts of the plant.



Systemic Acquired Resistance

- SAR confers **broad-based resistance** to different pathogens. For example, primary inoculation with a fungal leaf spot pathogen reduces susceptibility of the host plant to other fungi as well as to bacterial and viral pathogens
- Salicylic acid (chemical related to aspirin) is part of signaling pathway involved in transmission of the defense response throughout the plant to produce SAR. This has led to the development of synthetic chemicals that mimic the role of salicylic acid

Induction of Systemic Acquired Resistance

- 1- Plant is 'primed' to rapidly produce reactive oxygen species (e.g. H_2O_2) plus antioxidants

Hydrogen peroxide is directly toxic to invading pathogens

- 2 - Thickening of plant cell walls

Production of phenolics (lignin, tannic acid) that strengthen walls and inhibit pathogen enzymes

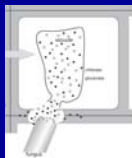
- 3- Accumulation of pathogenesis related proteins

"PR-proteins" enzymes that degrade fungal cell walls: chitinases, β -1,3 Glucanases

These enzymes accumulate in vacuole of plant cell. Upon attack, they directly degrade fungal cell walls. Indirectly, their action results in the release of fungal wall components that elicit additional defense reactions



Sprayed inducer (activator) that mimics salicylic acid



A plant's dilemma:

How much of its resources should be devoted to defense?

Wild type plant with inducible SAR

Mutant plant with constitutive SAR

Inoculated with water Inoculated with mildew pathogen



Bowling et. al., The Plant Cell, Vol. 6, 1845-1857, December 1994

Plants can have more than one type of acquired resistance

