



Cryphonectria parasitica tendrils on chestnut tree bark (Photo: Ministry of Agriculture and Regional Development Archive, Ministry of Agriculture and Regional Development, Bugwood.org)



Chestnut Blights



B3 Summer Science Camp
at Olympic High School

Chestnut Blight - #1

- *Cryphonectria parasitica* is a fungus (Ascomycete) that affects mostly chestnuts, but also some oaks.
 - The fungus forms orange-yellow fruiting bodies that are easy to see.
 - They form a canker on the tree stems (both trunk and branches).
 - They cannot enter the roots.



Asexual state

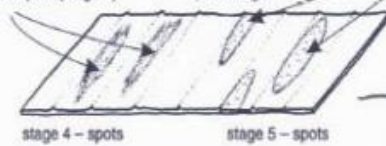
Type I spores — conidiospores (conidia)

Short distance spread only from within the plantation

Conidiospores produced on spots all year



Conidiospores produced on sporodochia on surface of spots (stage 4)

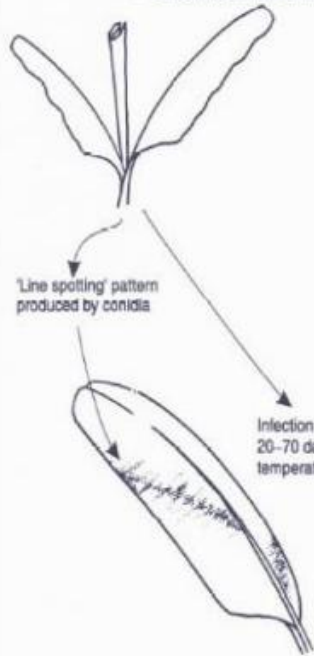


individual leaf spots enlarged

stage 4 — spots

stage 5 — spots

Conidiospores removed from spots by drops of water (rain, dew, irrigation) and move down with the drops to settle in folds in the unfurling leaves.



'Line spotting' pattern produced by conidia

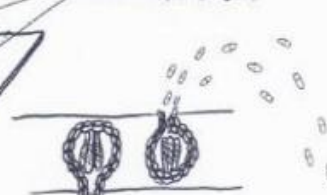
Infection to first symptoms 20-70 days depending on temperature and moisture

Sexual state

Type II spores — ascospores

Long and short distance spread from within and from other plantations

Ascospores produced in perithecia inside leaf spots (stage 5)



Ascospores shot out when leaves are wet

Ascospores drift upwards in air currents and settle on under surface of leaves, mostly near the tip



Ascospores only produced during warm, wet weather

Spots mature in 5-70 days depending on disease intensity and temperature

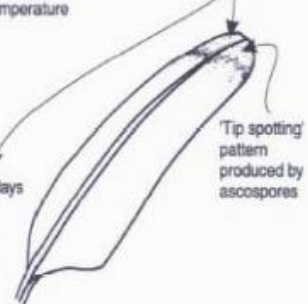


stage 2a & 2b — yellow streaks

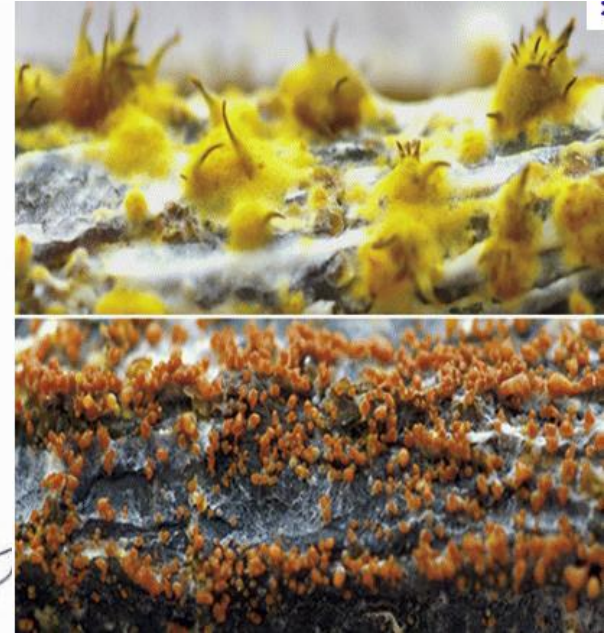


stage 1 — yellow specks

Infection to first symptoms 20-70 days depending on temperature and moisture

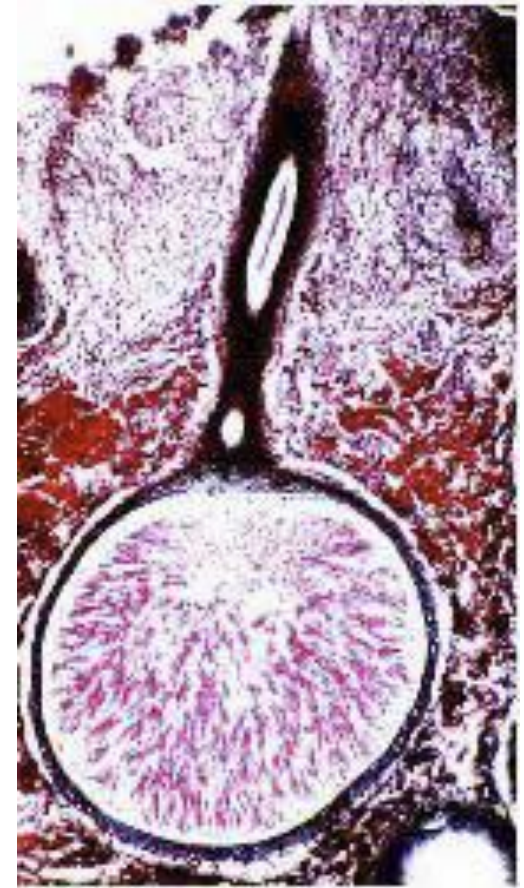


'Tip spotting' pattern produced by ascospores



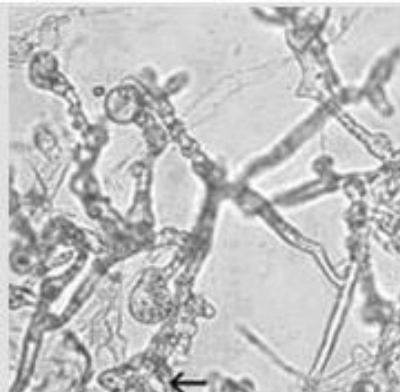
Drawings: Ron Peterson and Carole Kroger.

Cryphonectria parasitica up close



Chestnut Blight - #2

- Phytophthora (fie-toff-thora) cinnamomi: The Plant Destroyer
 - ~60 species are known
 - A soil fungus that destroys root tissue and stems – roots cannot absorb water



Hyphae, the vegetative state of *Phytophthora cinnamomi*



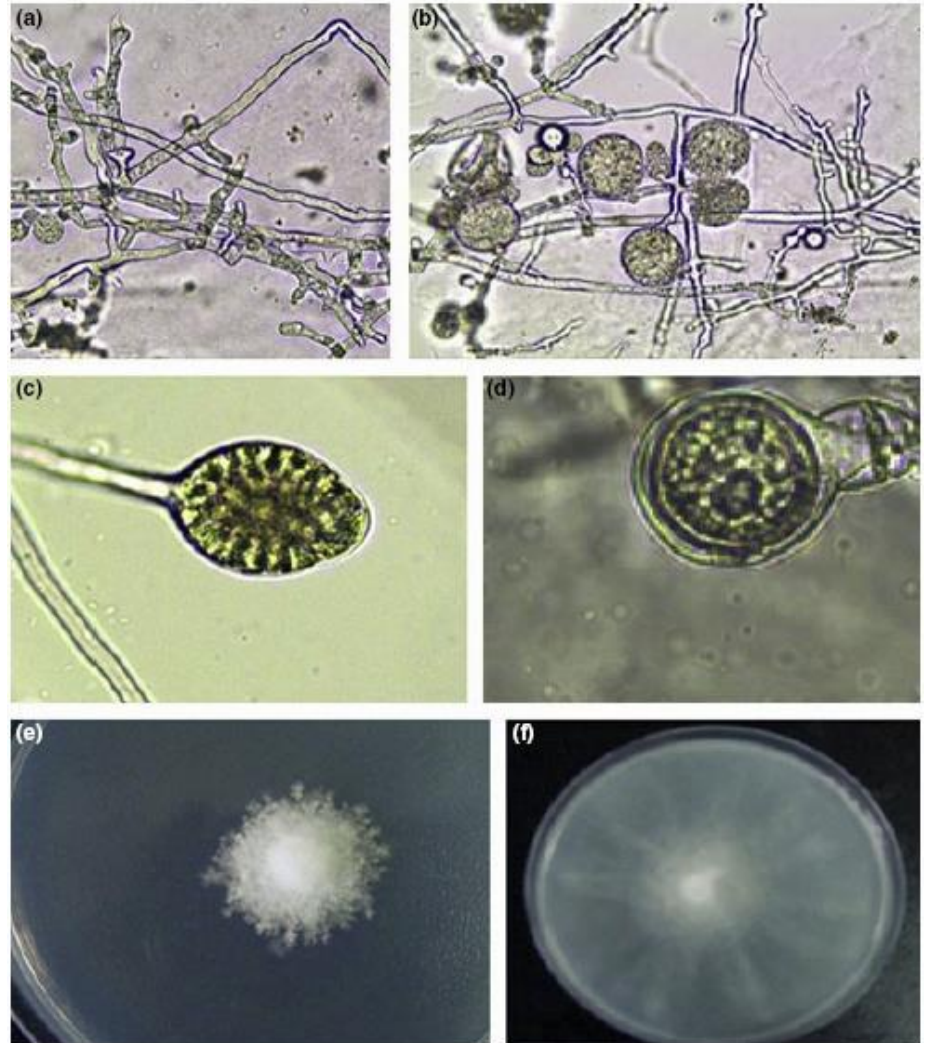
Sporangium with zoospores, the main reproductive propagule, of *Phytophthora cinnamomi*

Phytophthora blighted trees



Phytophthora up close

- Mycelia spores (a,b)
- 2-celled version (c,d)
- 5d colony on 2 types of media (e,f)



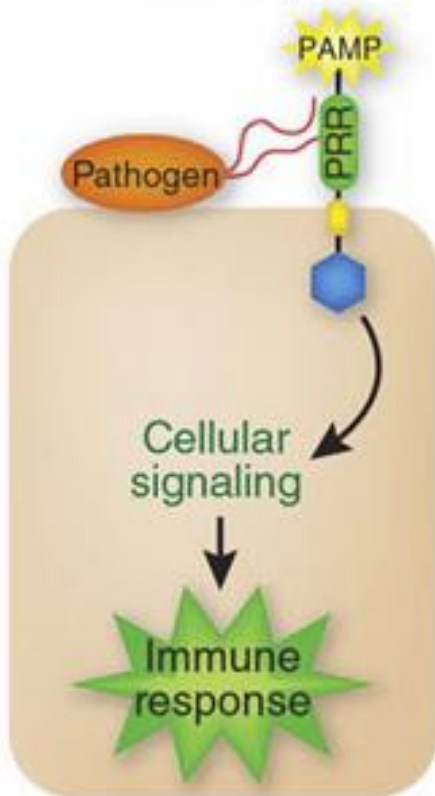
Plants and their pathogens

- In mammals the immune system can adapt in real time to invasion by pathogens
- Plants lack an adaptive immune system – their resistance occurs in 3 ways
 - Specific genetic material, the gene-for-gene method
 - A general chemical arsenal (taxol, salicylic acid, etc)
 - The Hypersensitive Response (HR) which is programmed cell death.

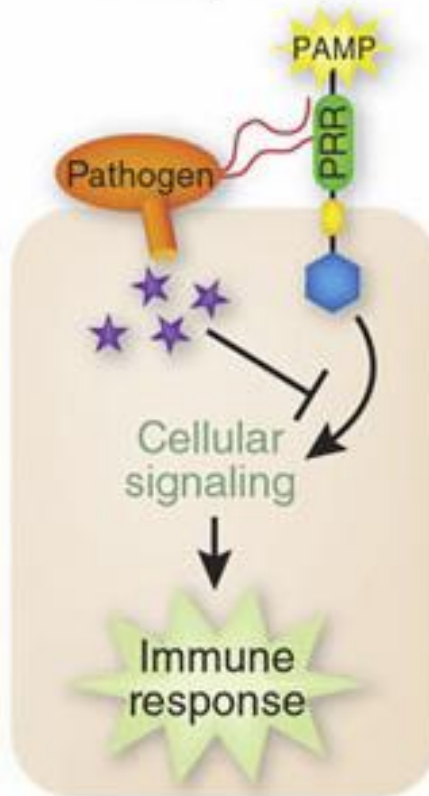
Plant-Pathogen Warfare

- Pathogen-Associated Molecular Patterns (PAMPs) lead to PAMP-Triggered Immunity (PTI)
 - PAMPs are proteins in the pathogen that the plant recognizes with specialized receptors (plant-recognition receptors, PRRs)
 - The interaction starts a signalling cascade and the cell responds by thickening the cell wall, producing toxic compounds, etc.
- Pathogens fight back: a type III secretion system in the pathogen will inject proteins into the host that block the PTI.
 - Virulence proteins are called effectors
- Plants fight back: Effector-triggered Immunity in the plant blocks the effector proteins

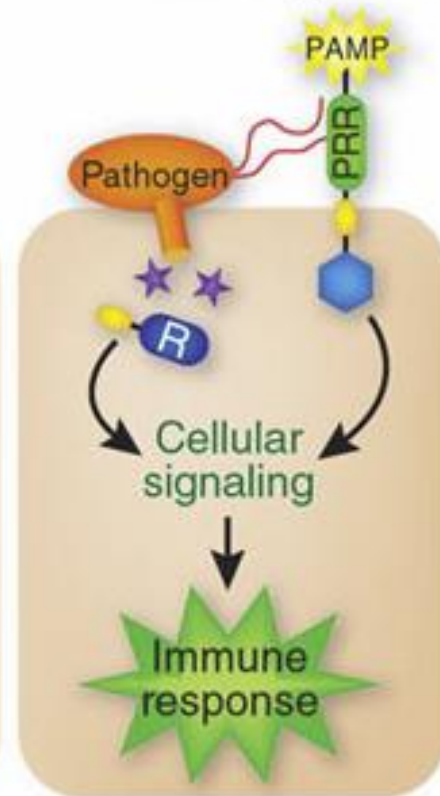
PAMP-triggered immunity



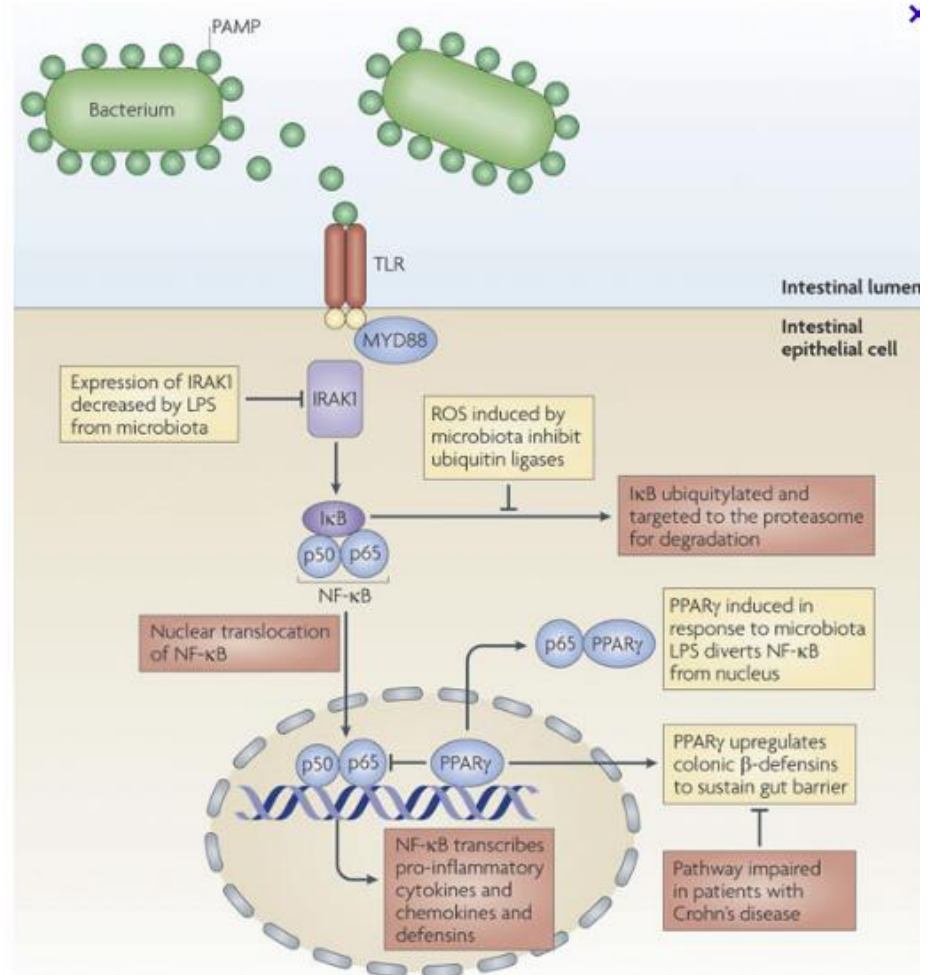
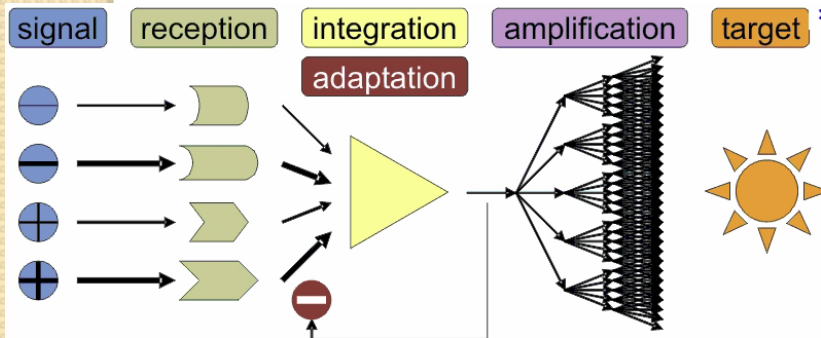
Effector-triggered susceptibility



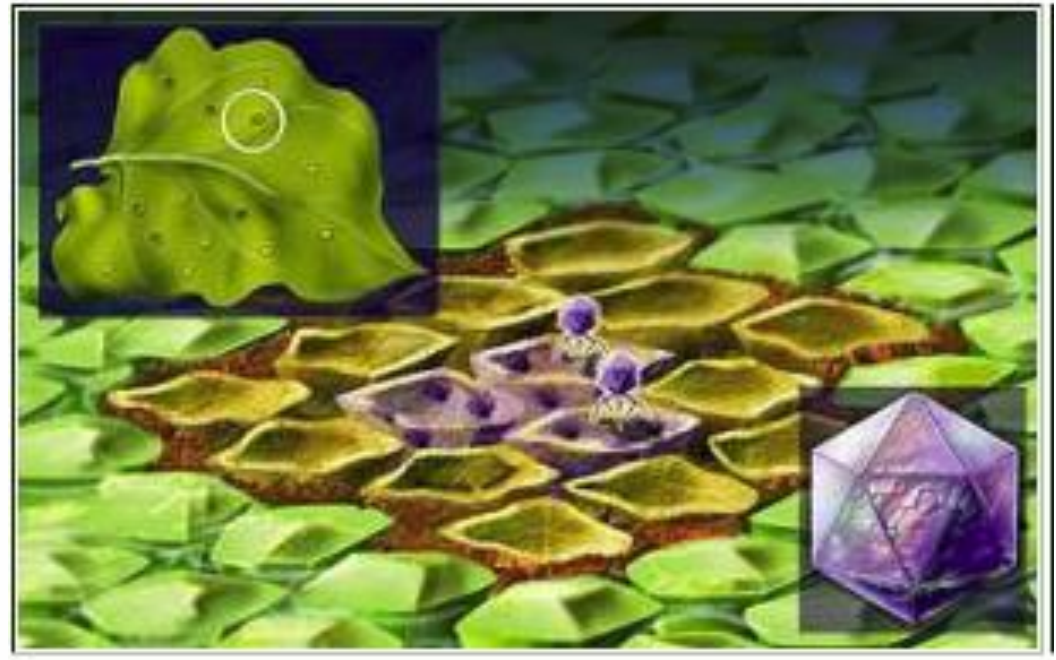
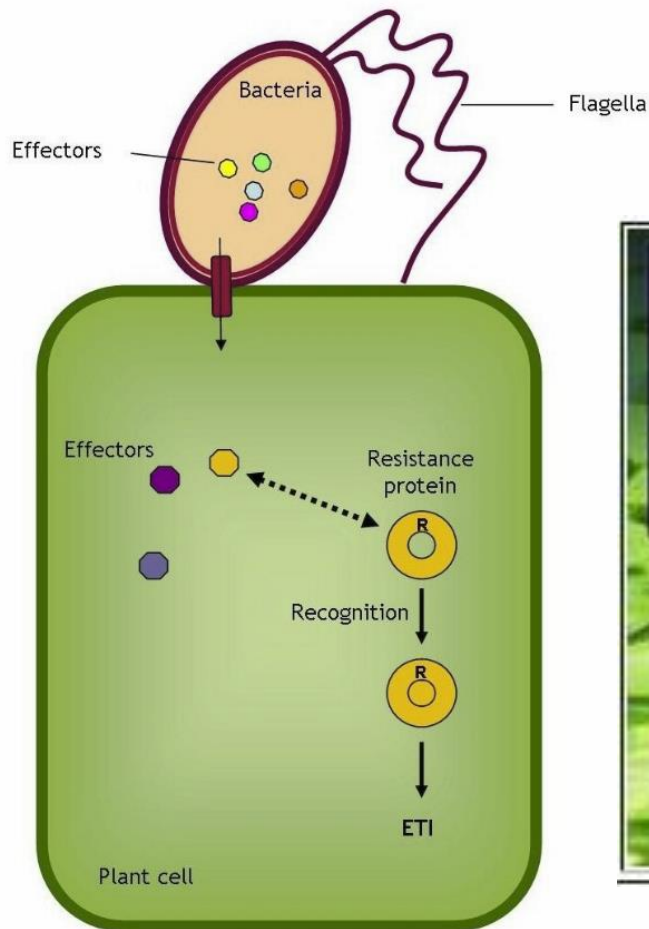
Effector-triggered immunity



The Signalling Cascade

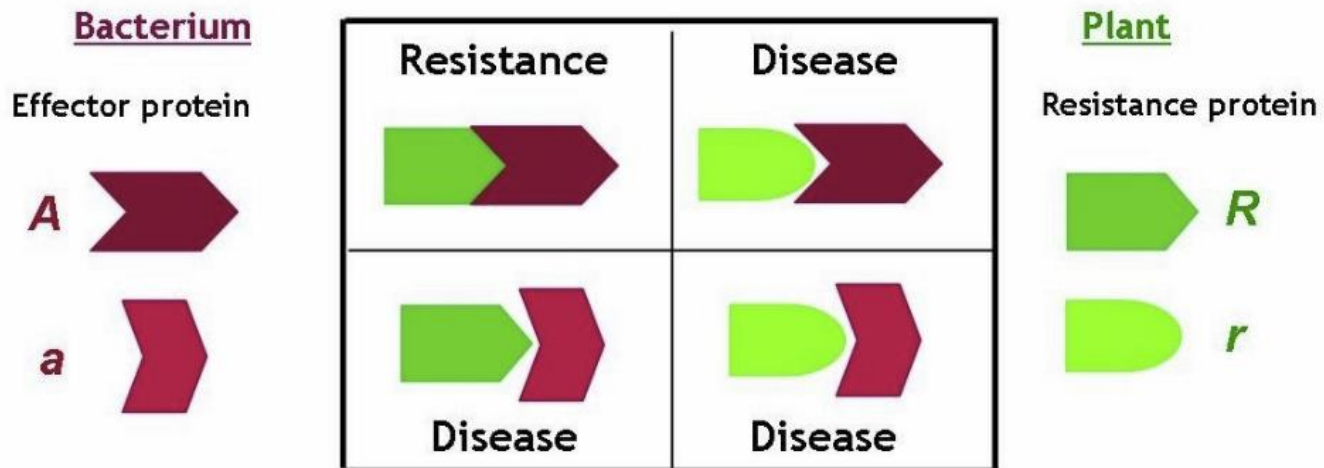


Plant-Pathogen Warfare - The Hypersensitive Response in pictures



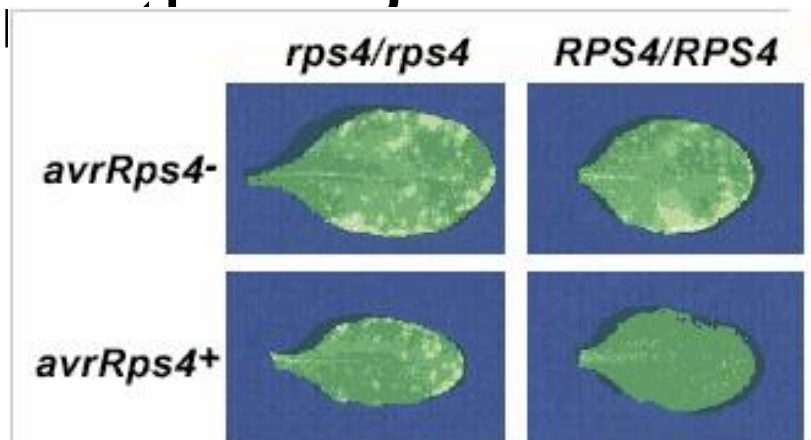
The Gene-for-Gene Model of Plant Immunity

Bacterium	Plant Resistance gene	<i>R</i>	<i>r</i>
	Effector gene		
	<i>A</i>	Resistance	Disease
	<i>a</i>	Disease	Disease



Gene-for-Gene testing

- What type of experiment might you design to test whether a plant has a resistance gene for a particular pathogen?



Gene-for-gene resistance conferred by the A. thaliana RPS4 gene. Leaves were inoculated with Pseudomonas syringae. Disease (chlorosis) occurs when the host resistance gene (left column) or the pathogen avirulence gene (top row) is absent. Resistance only ensues when both genes are present.

Creating resistant plants

- One pathogen (*Cryphonectria parasitica*) killed 4 billion trees over 50 years, in an area the size of Montana.
 - 1 tree in 5 in the forests died: oak, hickory and birch surviving of the hard woods
- This implies no natural resistance in the trees.
What strategies does that leave us?
 - Breeding in natural resistance from related species
 - This mixes genomes and some traits unique to the American Chestnut may be lost
 - Use biotechnological approaches to insert just the resistance genes

TACF's Backcross Breeding Program

Each generation select for:

- ❖ Blight resistance
- ❖ American characteristics

Final Product: Goal is true-breeding American type with a high level of blight resistance

