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

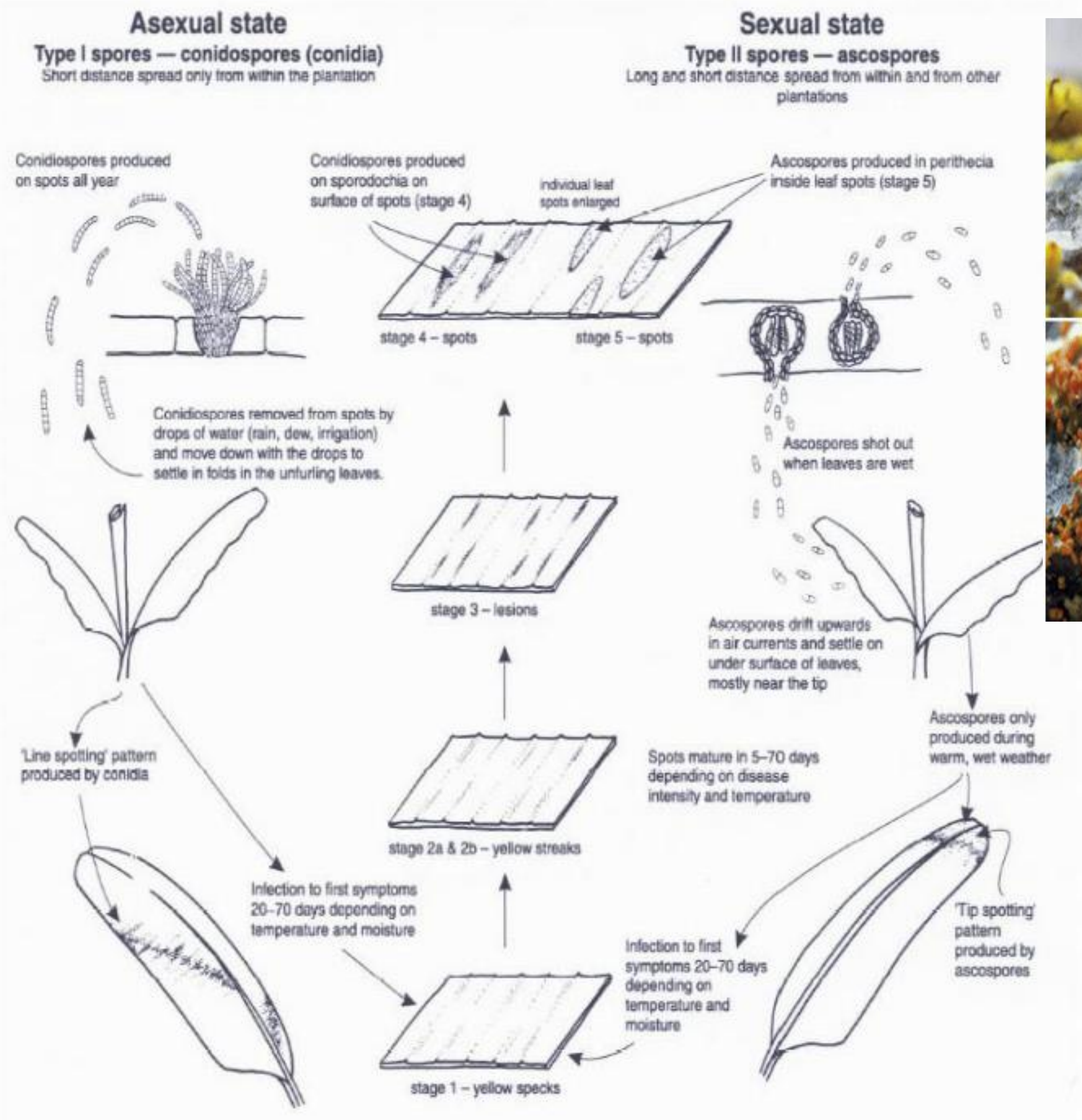
B3 Summer Science Camp at Olympic High School - 2016

Chestnut Blight - #1

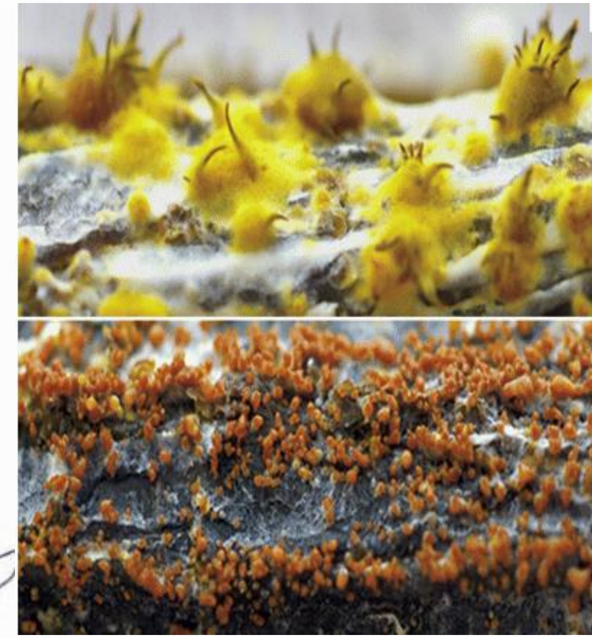
- *Cryphonectria parasitica* is a fungus (Ascomycete) that affects mostly chestnuts, but also some oaks.
  - The fungus forms orange-yellow fruiting bodies that are easy to see.
  - They form a canker on the tree stems (both trunk and branches).
  - They cannot enter the roots.

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

Damage by Chestnut blight (Photo: Robert L. Anderson, USDA Forest Service, www.forestryimages.org)



Drawings: Ron Peterson and Carole Kroger.

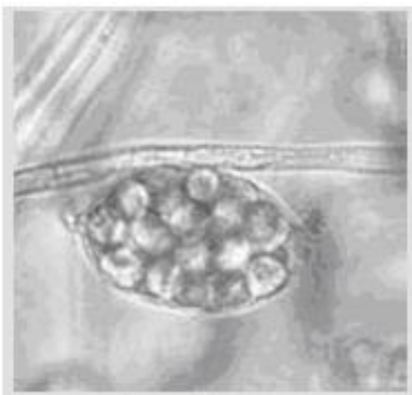


Cryphonectria parasitica up close

Chestnut Blight - #2

- Phytophtora (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)

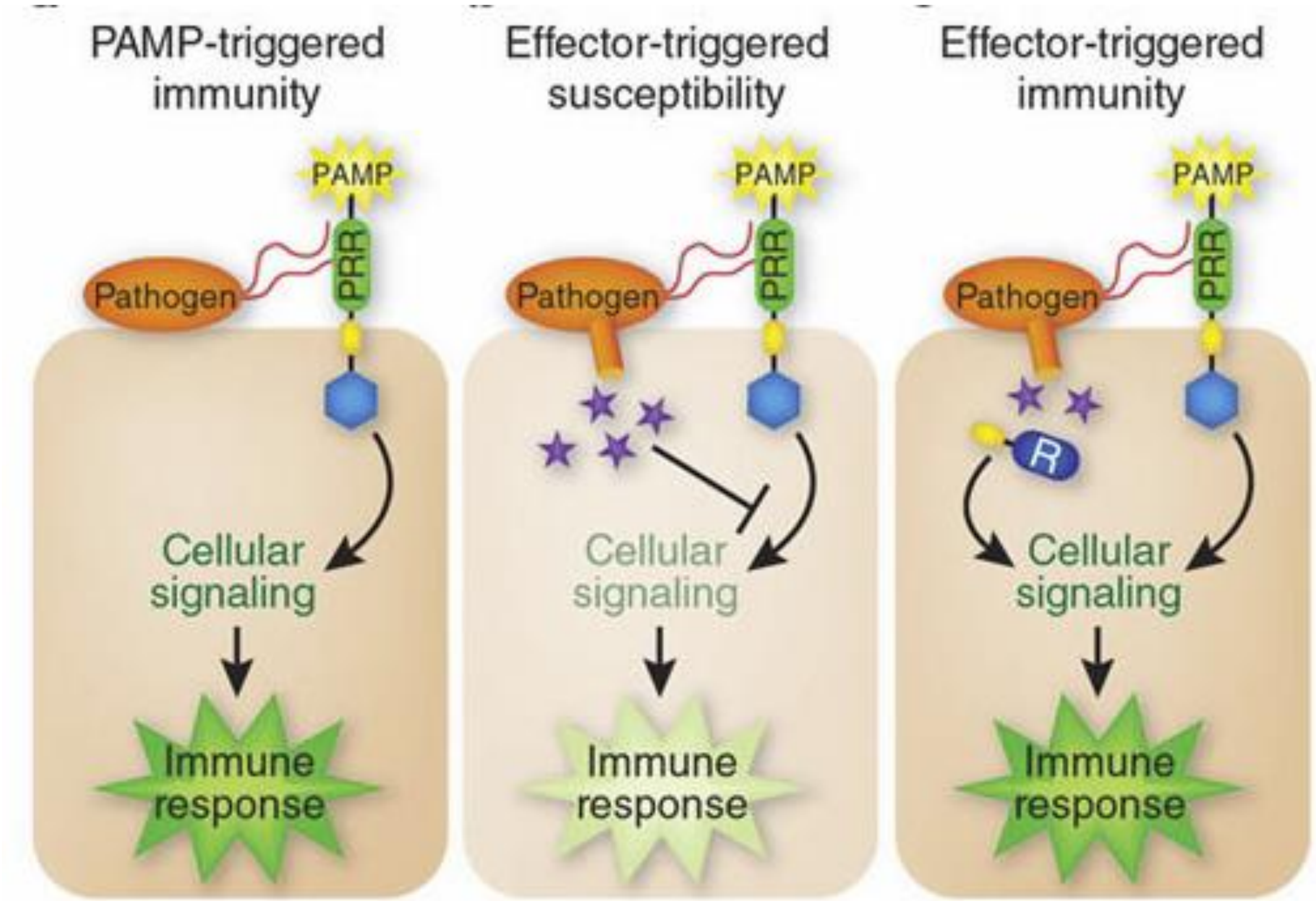
Plants and their pathogens

- 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.

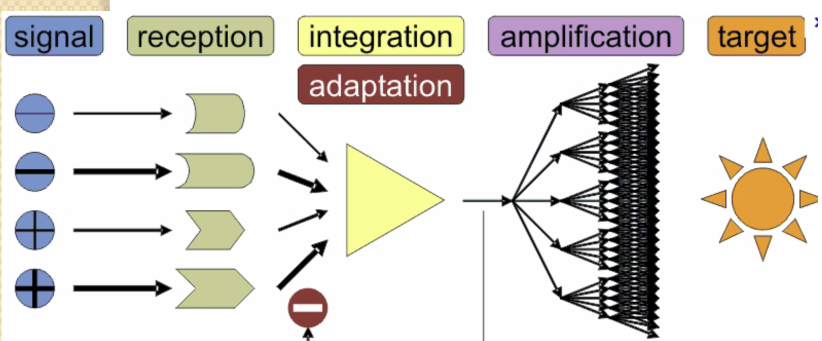
Plant-Pathogen Warfare

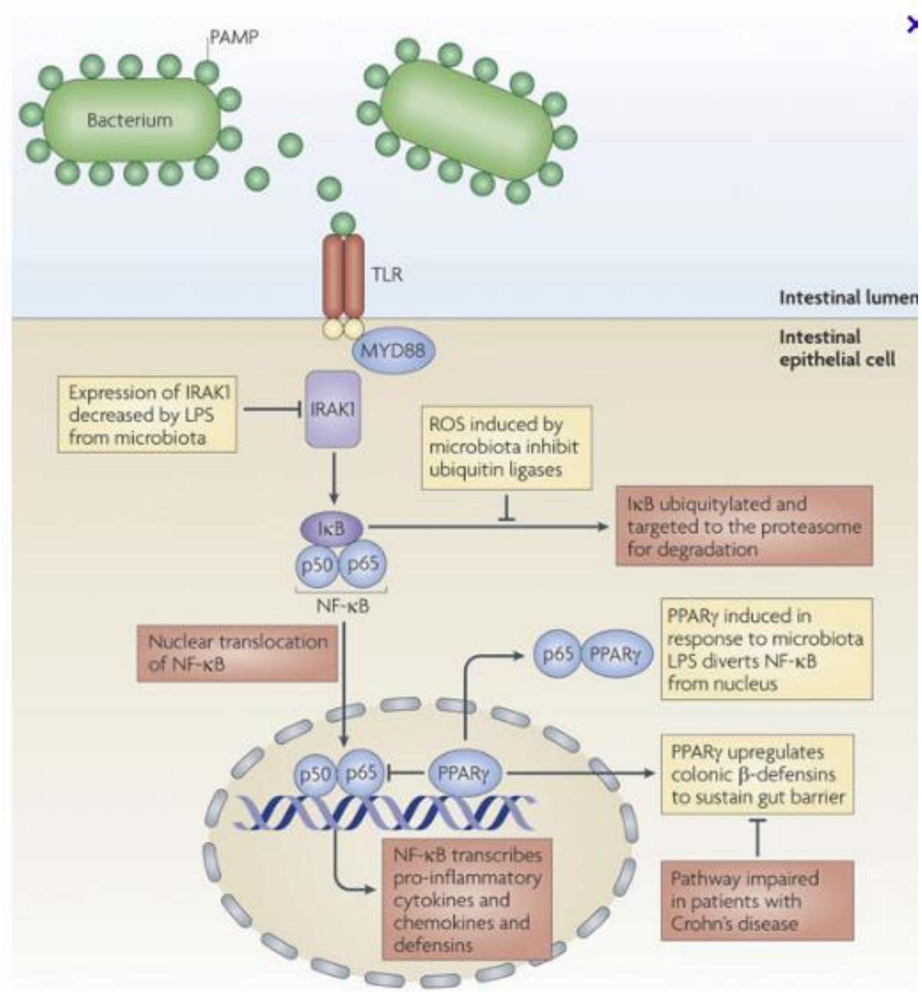
- Pathogen-Associated Molecular Patterns (PAMPs) lead to PAMP-Triggered Immunity (PTI)
  - PAMPs are proteins in the pathogen that the plant recognizes with specialized receptors (plant-recognition receptors, PPRs)
  - The interaction starts a signalling cascade and the cell responds by thickening the 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
  - When the Effector-triggered immune protein binds to the effector the result is programmed cell death, the hypersensitive response.

Plant Immunity

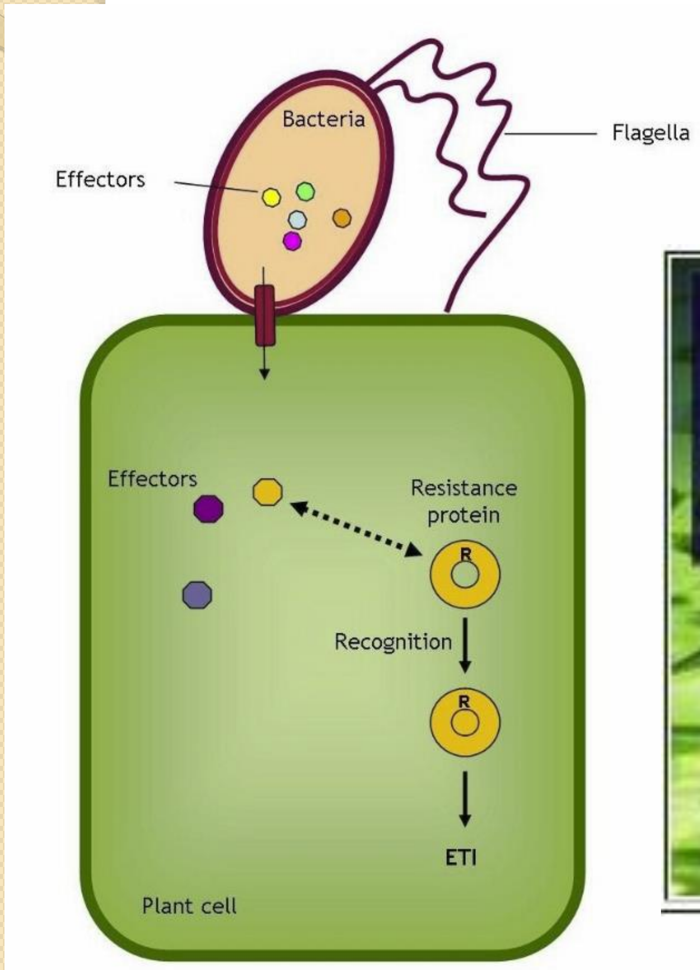


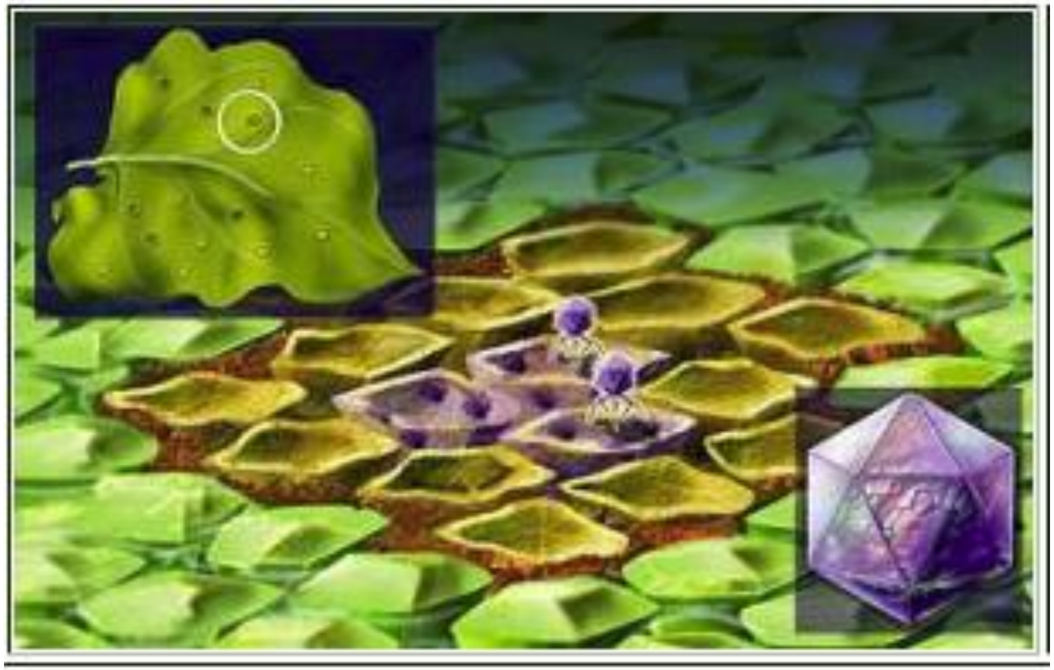
The Signalling Cascade





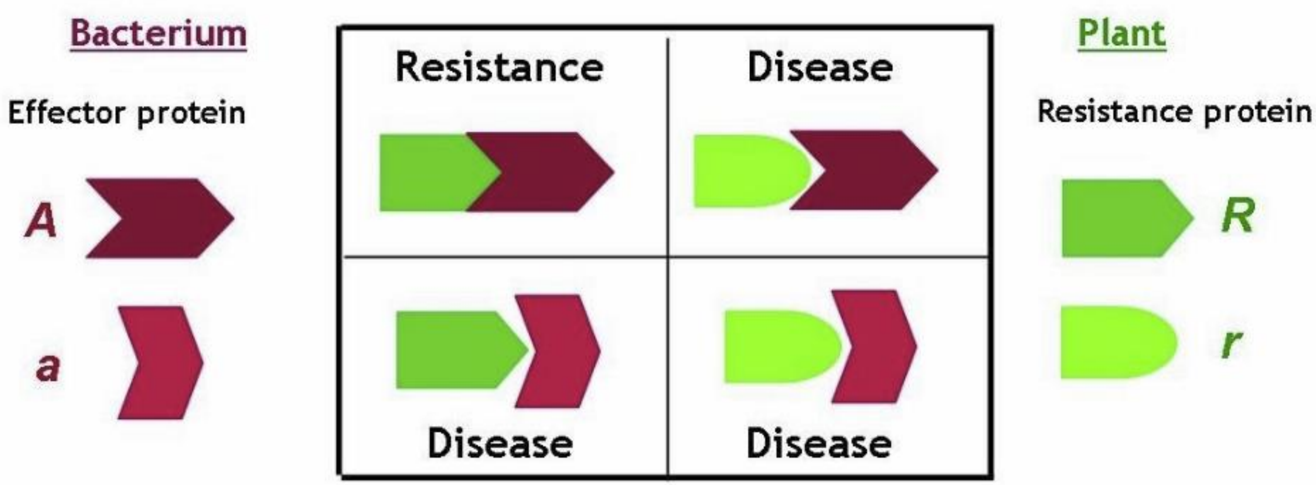
Plant-Pathogen Warfare - The Hypersensitive Response in pictures





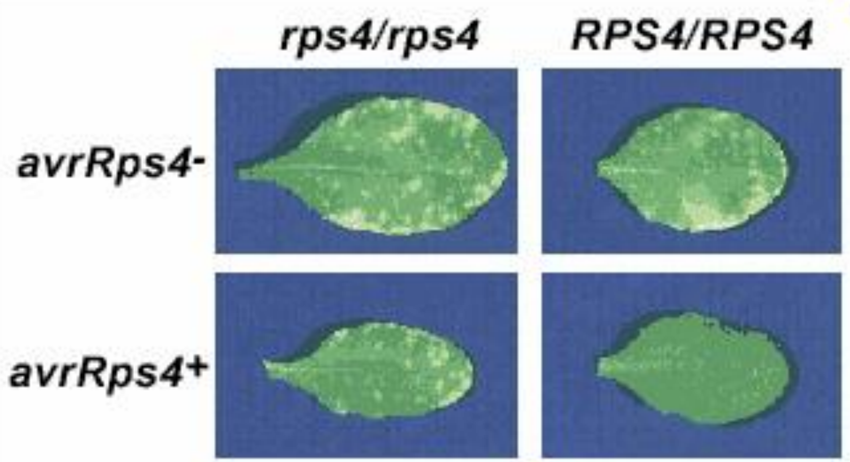
The Gene-for-Gene Model of Plant Immunity

Bacterium: Effector gene / Plant: Resistance gene	*R*	*r*
A	Resistance	Disease
a	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 tress 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
    - Infect the fungus with a virus that kills is (hypovirulence)