Plant Pathology

for Master Gardeners in the Central Arizona Highlands

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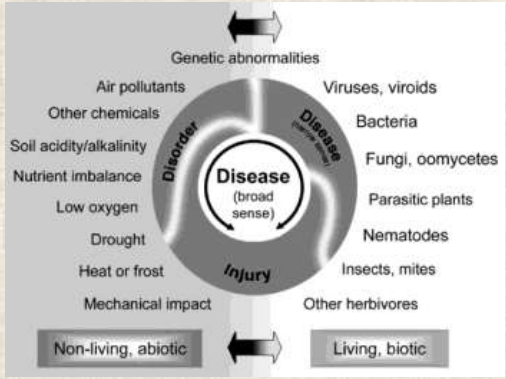
Master Gardener

April 28, 2020

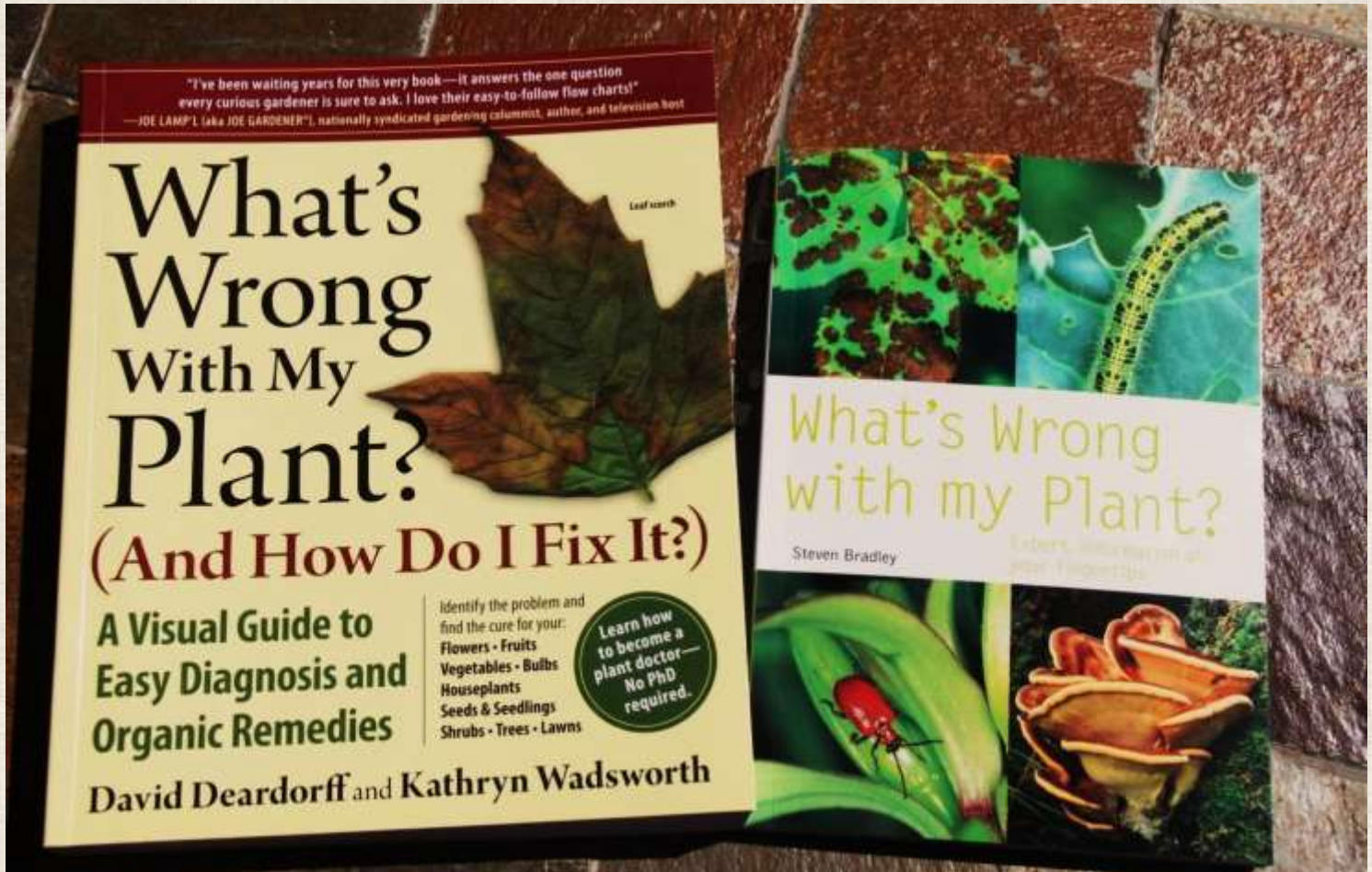
Outline

- Plant Disease Basics
- Plant Disease Diagnosis
- Common Local Diseases
- Plant Disease, Pest, and Problem Specimens

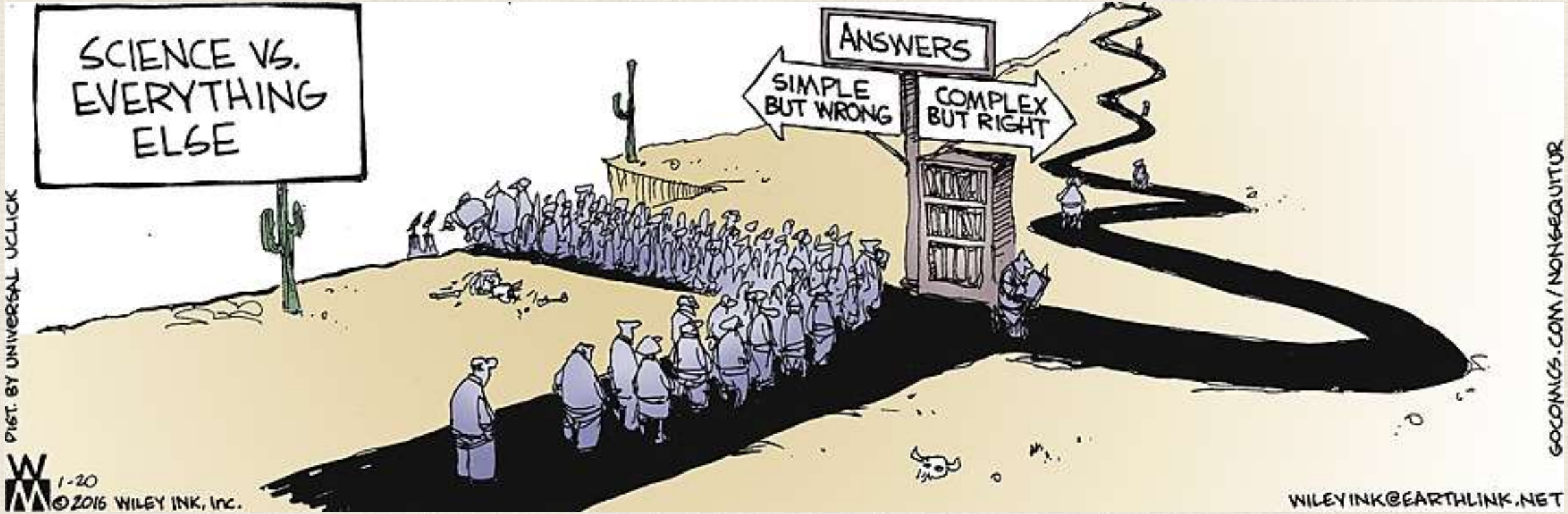


So You Want to be Master Gardener!

- Common Questions the public will ask you:
  - What's Wrong With My Plant?
  - How Do I Fix It?

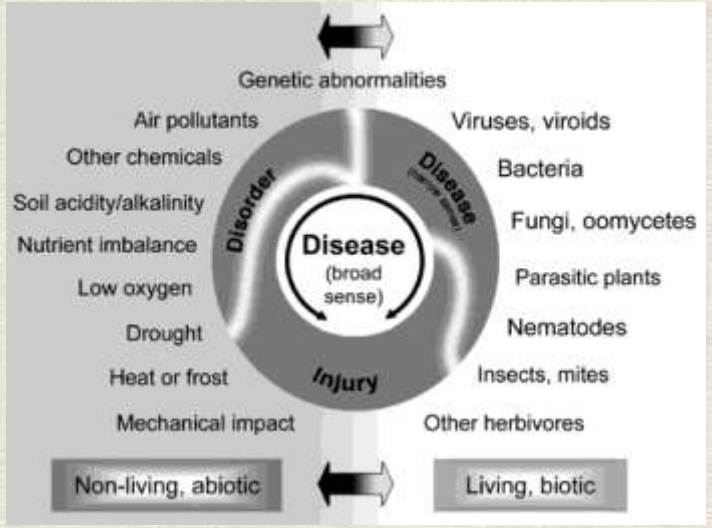


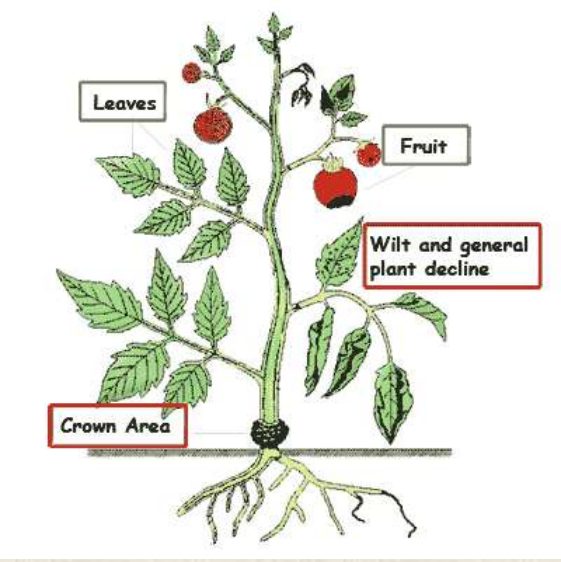
“Scientific Based Horticultural Information”

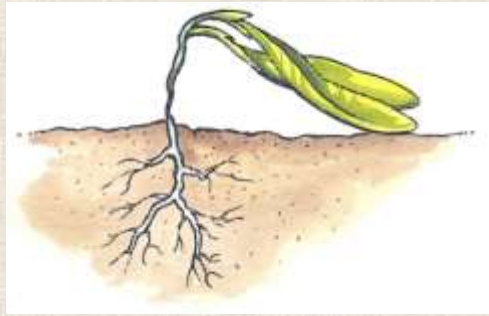


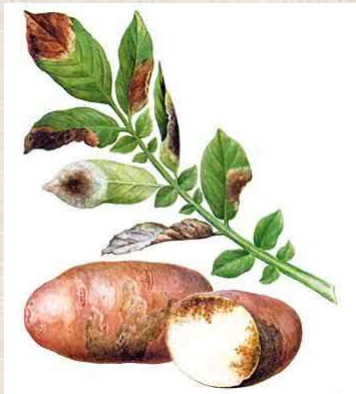
What is Plant Pathology?

- Study of Plant Diseases
  - Host plants
  - Plant pathogens
  - Environmental factors
  - Interactions of host, pathogen, and environment
  - Management/control
  - Genetics, molecular biology, mathematical modeling to predict disease outbreaks





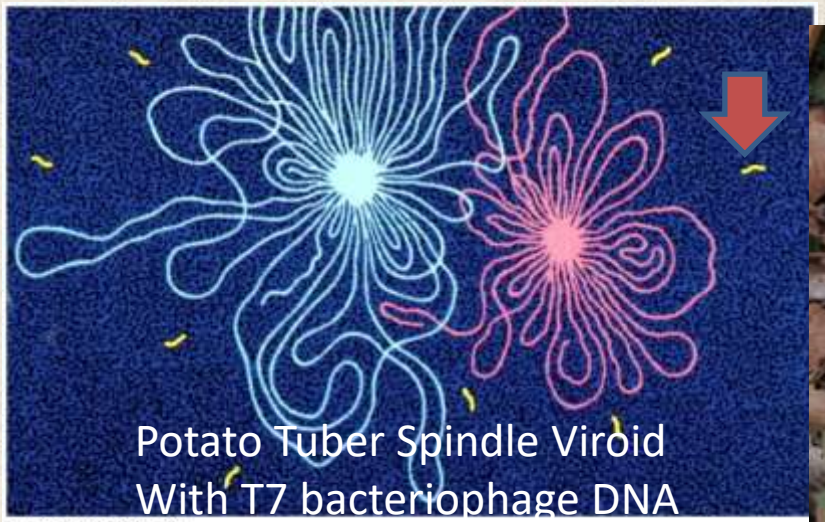




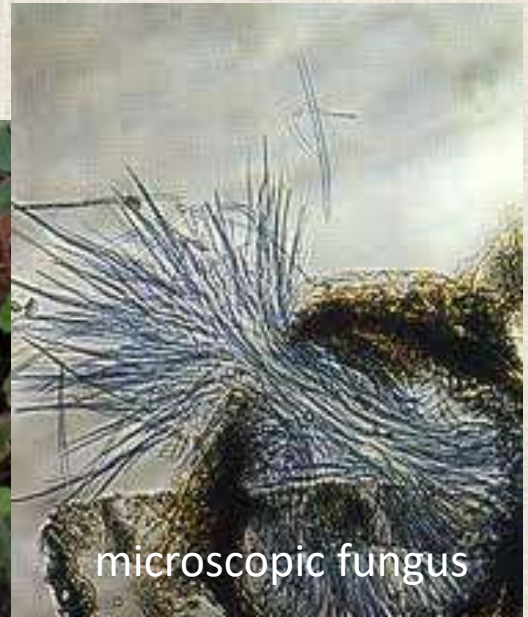
What is Plant Disease?

- Disturbance of normal functioning (physiology) of plant
- Many causes and appearances
  - Biotic and/or abiotic agents
  - Continuum of potential causes
    - Microbial pathogens to physical injuries


improper pruning (topping)


Potato Tuber Spindle Viroid With T7 bacteriophage DNA


Conk


microscopic fungus

Diseases vs. Nondisease Problems

- Disease
  - Pathogenic organism, virus, or viroid
  - Environmental cause
- Non-disease problems (Pests)
  - Invertebrates - insects, mites, snails, slugs
  - Vertebrate pests including humans
  - Weed competition

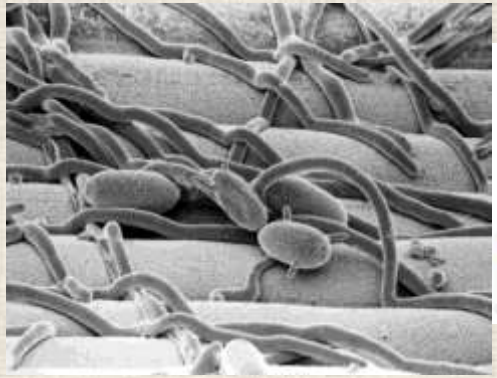
Disease Determining Factors

Susceptible
HOST PLANT

Virulent
PATHOGEN

Disease Tetrahedron

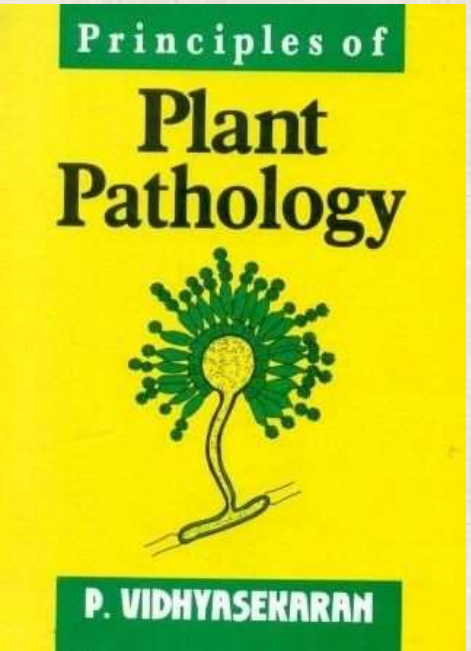
Enough
TIME



Favorable
ENVIRONMENT

How Master Gardeners Can Diagnose Plant Diseases!

- Understand plant pathology principles
  http://ceventura.ucanr.edu/Environmental_Horticulture/Landscape/Problems/Pathology/
  - General concepts pertaining to plant pathology
- Know where to look up detailed information
  - Arizona plant disease resources
- Learn from your experiences
  - Classes, readings, observations over time, knowledgeable people



Arizona Plant Disease Resources

- Diseases of Urban Plants in Arizona - Mary Olsen AZ1124 (April 1999)
  - https://www.google.com/search?client=firefox-b-1-d&q=plant+diseases+arizona

- Yavapai Plant Diseases
  - https://extension.arizona.edu/yavapai-plant-diseases
  - Comandra Blister Rust AZ1310
  - Common Tomato Disorders Under Desert Conditions Bulletin 56
  - Cotton (Texas) Root Rot AZ1150
  - Damping-off AZ1029
  - Fire Blight AZ1030
  - Mistletoes True Mistletoes AZ1308
  - Dwarf Mistletoes AZ1309
  - Powdery Mildew AZ1033
  - Seiridium Canker of Cypress Trees in Arizona AZ1557
  - Slime Flux AZ1031
  - Slime Molds Bulletin #60
  - Sooty Canker AZ1032

- Yavapai Plant Diseases and Photos
  - https://cals.arizona.edu/yavapai/diagnostics/diseases.htm

- Backyard Gardener Columns
  - https://cals.arizona.edu/yavapai/anr/hort/byg/

- Help Desk Library

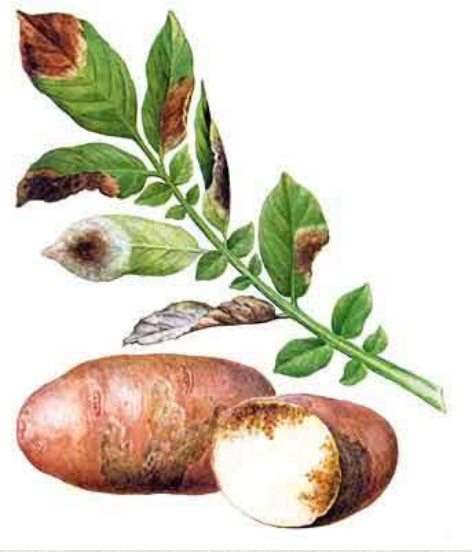
- Online Search
  - Key words and .edu for Cooperative Extension Information

Does a problem really exist?

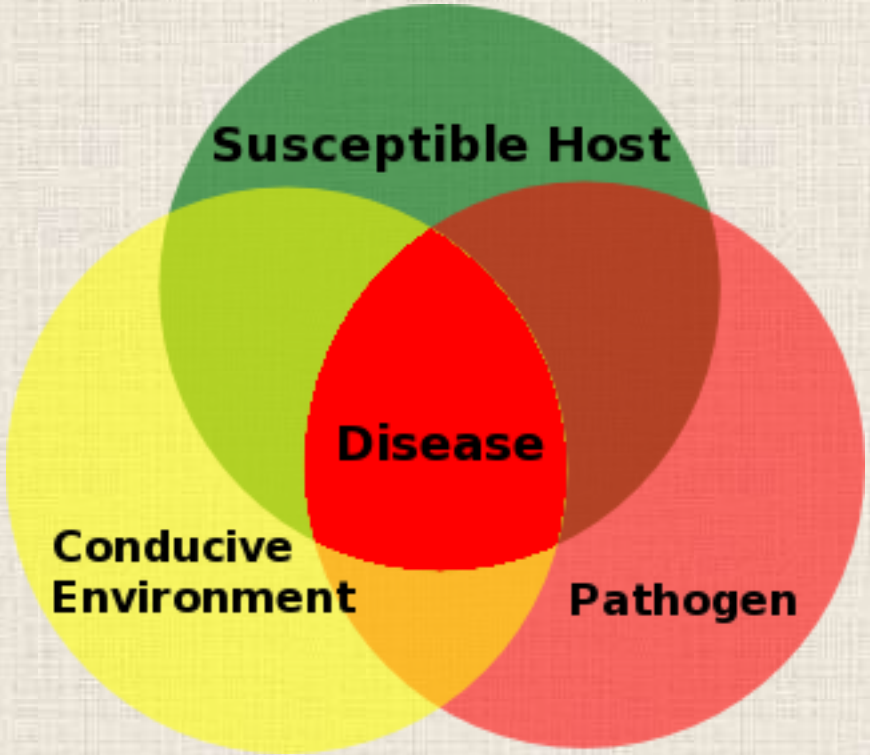
- How should this plant normally look?

Normal or Abnormal?

Why Study Plant Pathology?

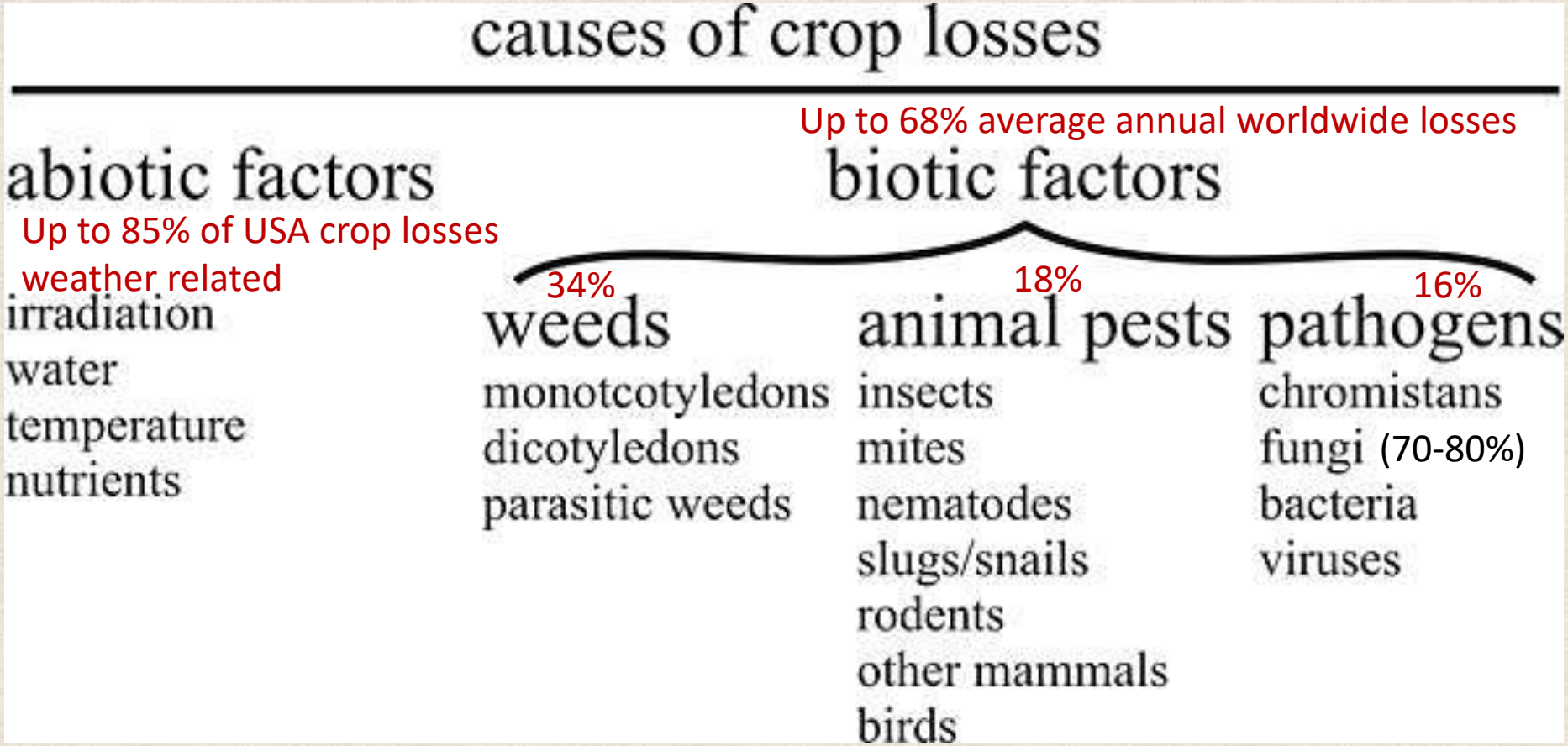


– Food supply, human health, starvation, jobs, capitalism
– Appearance of plants maybe unacceptable



Loss Locations

Field/Growing Facilities
Harvesting
Storage
Transit
Home/businesses
Thrown away - 30% World,
- 50% USA



Crop Protection Costs (Herbicides, insecticides, and fungicides)

$53 bil. in 2017 ww, estimated $70 bil. by 2021 ww

https://agfax.com/2019/01/25/farming-weather-is-leading-cause-of-u-s-crop-loss-how-do-you-assess-the-risk/

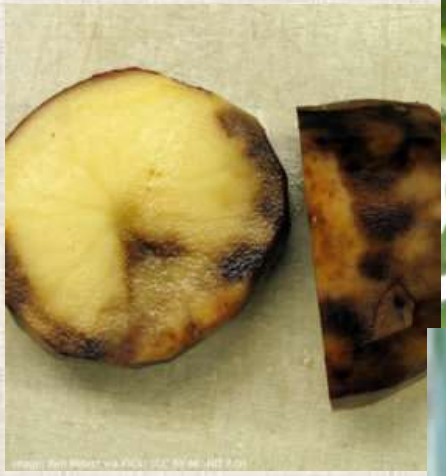
E.-C. Oerke 2006. Centenary Review: Crop losses to pests. Journal of Agricultural Science 144:31–43.

David Moore, Geoffrey D. Robson and Anthony P. J. Trinci 2018. 21st Century Guidebook to Fungi, 2018 SECOND EDITION

https://www.statista.com/statistics/272493/revenue-of-the-plant-protection-market-worldwide-since-2007/

https://www.marketsandmarkets.com/PressReleases/crop-protection.asp

Some Major Crop Losses from Diseases



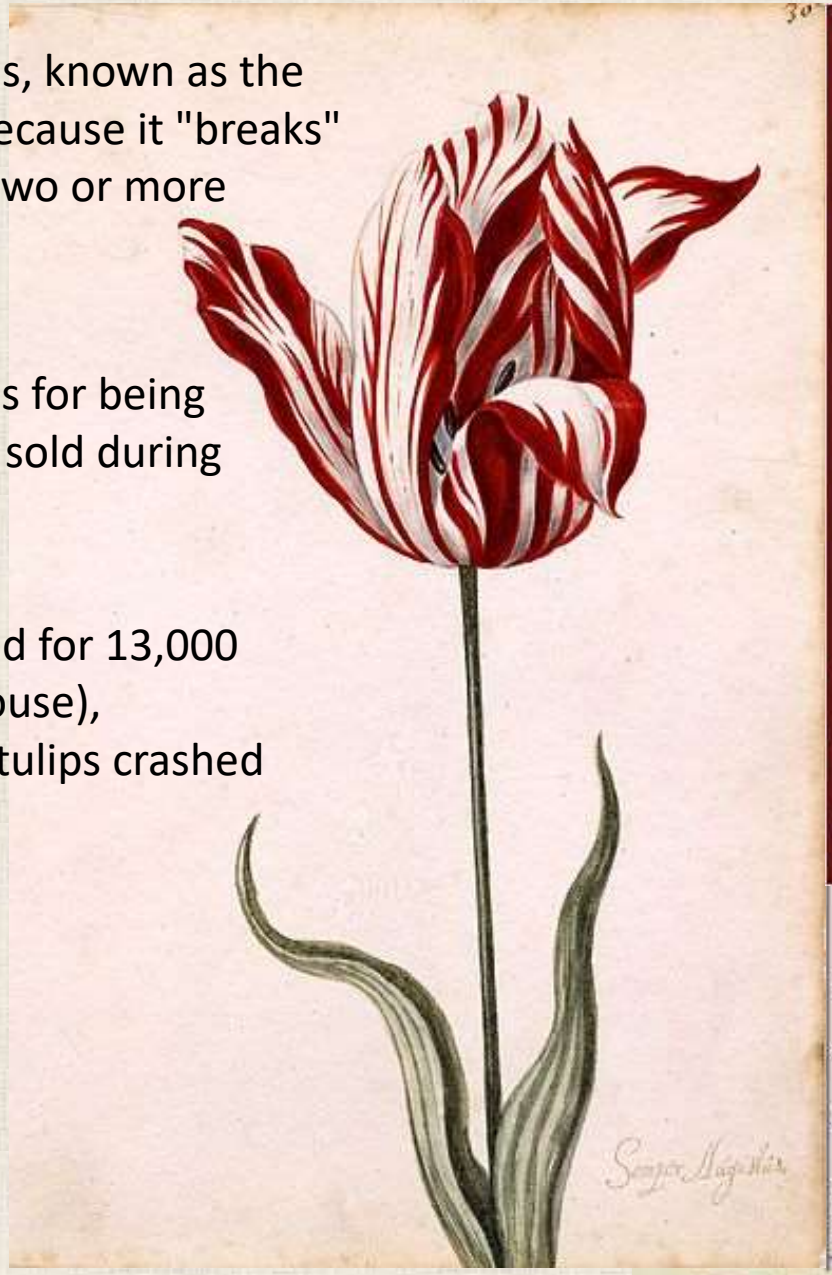
- Bible – blasts, mildews, rusts
- Romans – rust god, animal sacrifice
- Late Blight of Potato
  - 1840s, Ireland, 2.5 mil. die or immigrate
- Downey Mildew of Grape
  - 1878-1885, devastated French wine industry, Bordeaux mixture
- Stem Rust of Wheat
  - 1916, 1935,1953; losses in Great plains, >50%, plant breeding genetics
- Panama (Fusarium Wilt) Disease of Bananas
  - 1920s-1950s, Gros Michel, nearly wiped out; Cavendish, now new susceptible to races of fungus; genetic studies on banana clones
- Modern Devastating Diseases
  - wheat blast, Xylella (olives), maize lethal necrosis, coffee rust, striped wheat rust, citrus greening, citrus canker, papaya ring spot virus, cacao witches broom, s. corn leaf blight, rice bacterial leaf spot, rice brown disease, etc.

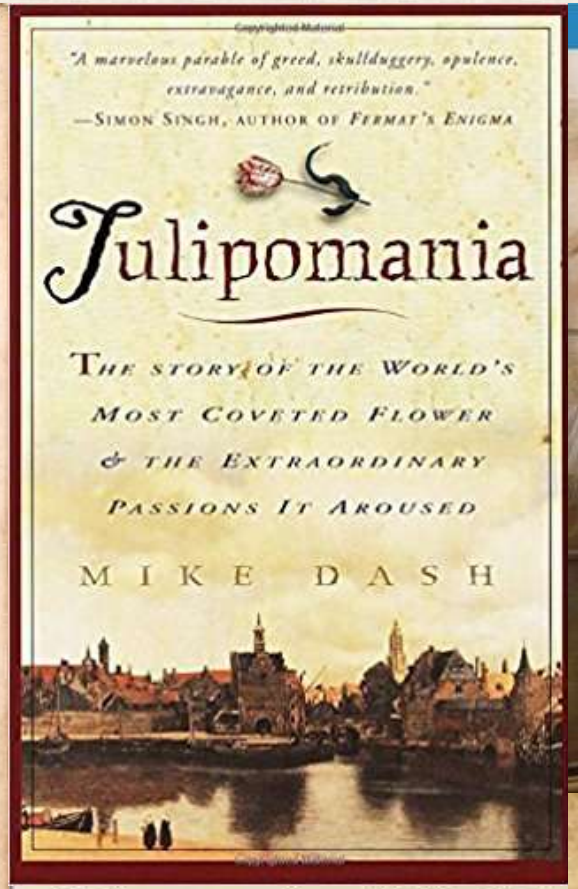
Tulip Mania

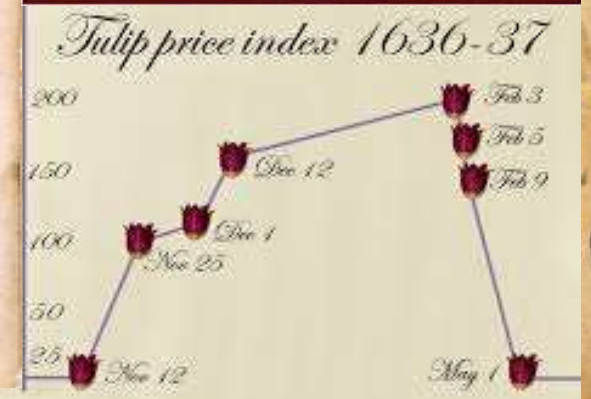
Tulip-specific mosaic virus, known as the "Tulip breaking virus", because it "breaks" the one petal color into two or more

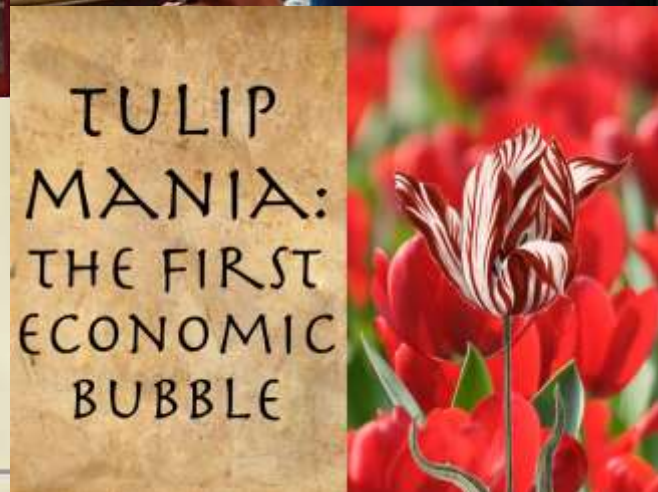
Semper Augustus, famous for being the most expensive tulip sold during Tulip Mania

1637 - one was advertised for 13,000 Florins (price of a nice house), that year the market for tulips crashed in the Netherlands







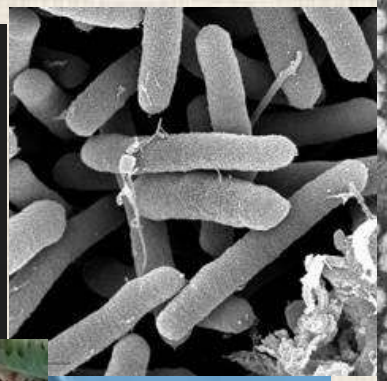


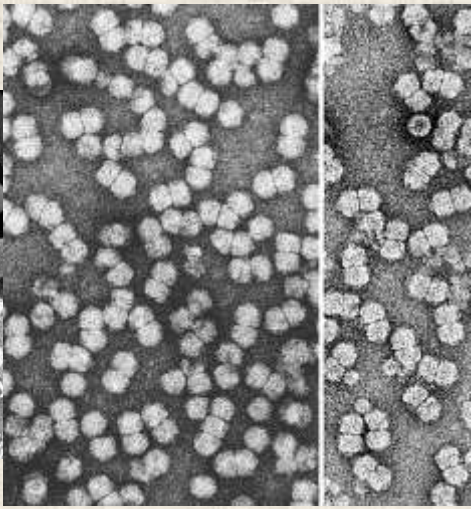
What about Home Gardens?

- Often use noncommercial cultivars (heirloom, resistant hybrids)
- Disease tolerance (accept some level of disease or cut out)
- Pesticide alternatives (manual, hose, soap, neem oil, etc.)
- Follow plant pathology principles (manage on small scale)

Symptoms and Signs

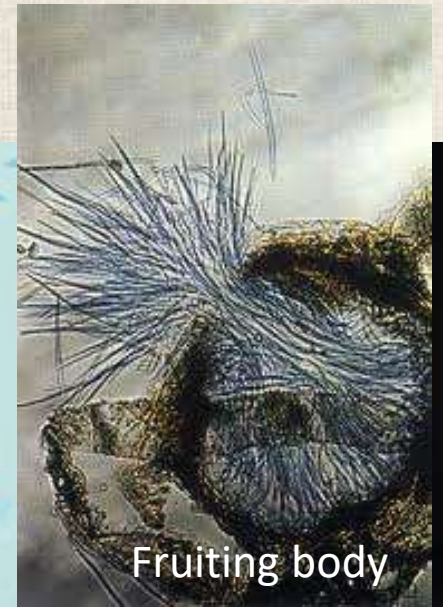
- Symptoms (host plant abnormality)
  - Expression of disease in host plant
  - Plant response, damage
- Signs (pathogen)
  - Organisms and there parts (fungi, bacteria, etc.)
  - Viruses, viroids

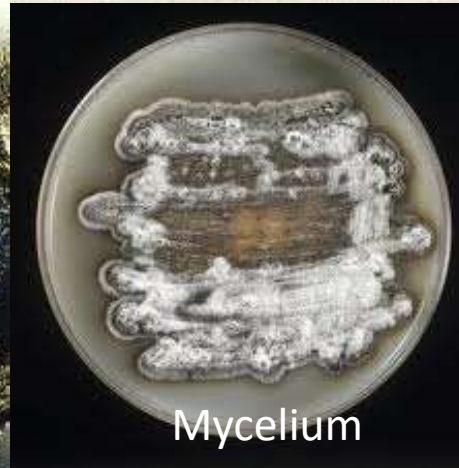




Diagnosing Plant Diseases

- Collect large enough sample so can identify:
  - Plant, symptoms, signs, etc.
- Take pictures
  - Appearance when fresh





Diagnosing Plant Diseases

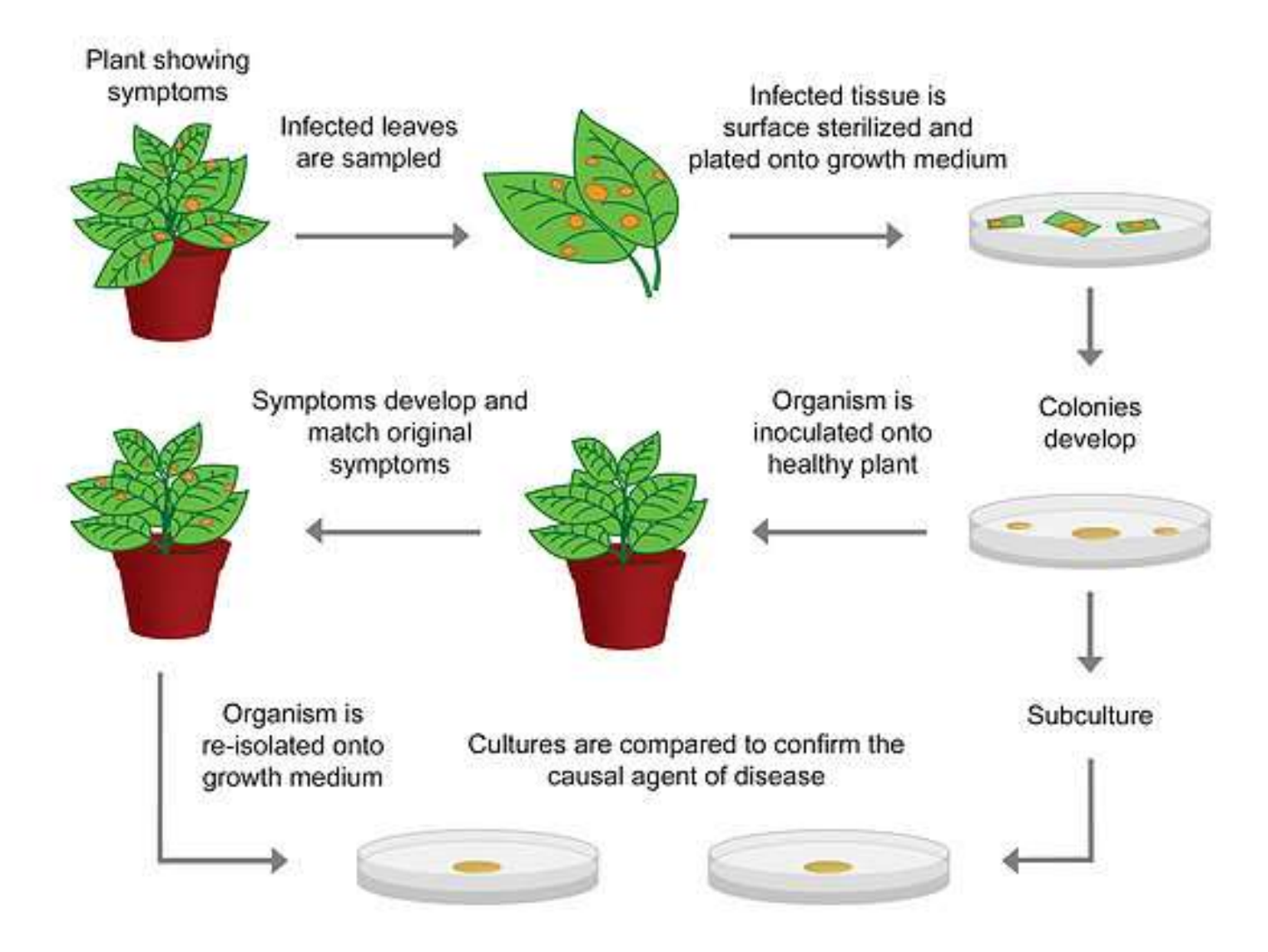
- Eliminate other possibilities
  - animal pests, weather, maintenance problems, etc.
- If a potential disease exists, you may need to know:
  - Plant species, maybe cultivar
  - Plant part affected
    - Foliar, stem, root, fruit problem
  - Type of abnormality
    - Symptoms
      - Changes seen in plant (leaf spot, canker, etc.)
  - Type of pathogen
    - Signs (causal agent)
      - Environmental factor, structures of pathogen

Septoria Leaf Spot of Tomato


Septoria Fruiting Body and Spores

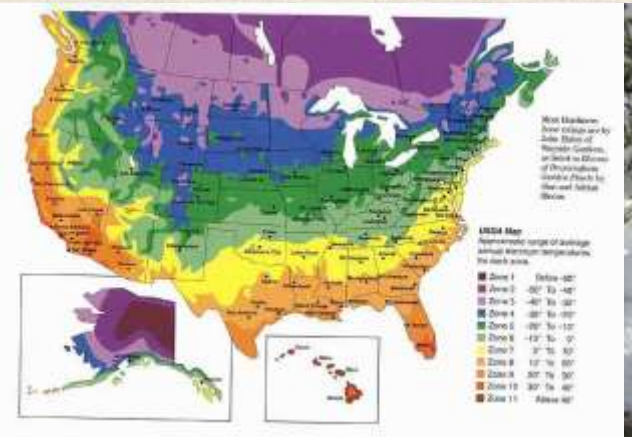
Koch's Postulates

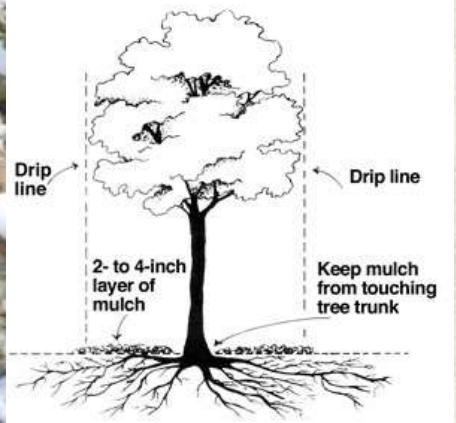
Proof that an Organism Causes Disease



Other useful Information needed to Diagnose Problem?

- Where is plant located?
- Has the plant been exposed to any extreme or unusual environmental conditions?
- How has the plant been cared for or neglected?
- Be prepared to say:
  - "I don't know but will research the available information"





VARIETY (genus and species, and/or common name of plant)_____

AGE OF THE PLANT: _____ **PLANTING DATE:** _____

SYMPTOMS (circle all that apply):
Plant parts affected: roots, crowns, stems, branches, leaves, fruit, whole plant.
Symptoms: spots, tipburn, distortion, mosaic or mottle, chlorosis (yellowing), rot, necrosis, mildew, blisters, defoliation, wilt, dieback, blight, stunting, canker, galls

Description (be as specific as possible, describe the whole plant - remember the clinician is only seeing the specimen submitted). _____

_____

When did symptoms first appear?_____
Are the symptoms (circle one): spreading or localized?
Symptom development (circle one): gradual or sudden?
Distribution of diseased plants (circle): scattered, clustered, in a row or pattern?
Number or percent of plant(s) infected_____

SOIL TYPE (circle all that apply): Sand, Silt, Clay, Well drained, Poorly drained, Heavy, Light.

GROWING CONDITIONS (circle all that apply): Indoors (home/office), Greenhouse, Home Garden, Lawn, Landscape, Organic Garden, Commercial Field. Other_____

WEATHER CONDITIONS (immediately prior to and during development of symptoms):
(Circle all that apply) Wet, Dry, Humid, Windy, Dusty, Hail
Temperature (°F)_____ Other Conditions_____

IRRIGATION HISTORY: (circle all that apply): Furrow, Flood, Drip, Sprinkler, Hand
How often?_____How much water is applied?_____

FERTILIZATION HISTORY: (type, nutrient ratio, amount applied, and frequency of application)
_____

CHEMICALS APPLIED (Chemical name, method and frequency of application and amount applied)
_____

CROPPING HISTORY (for agricultural fields or home gardens)
Rotation (previous 3 years)_____
Past Problems (in field)_____

OTHER INFORMATION:

**********Diagnostic Lab Use Only - Do Not Write In Box**********

Sample Condition:	Information Received:	
☐ Excellent / 1	☐ Complete / 1	☐ Photo or digital image
☐ Good / 2	☐ Partial, some useful information / 2	Quality? _____
☐ Fair / 3	☐ Incomplete / 3	
☐ Insufficient / 4	☐ None / 4	Total:_____

Diagnosis: Complete / Not Complete **Explanation:**_____

Types of Plant Diseases
Based on General Type of Causal Agent

- **Biotic Diseases** (Pathogens cause)
  - Symptoms: on specific plants or plant parts
  - Progression of symptoms
    - invasion of tissues (infectious)

- **Abiotic Diseases** (Environmental factors cause)
  - Symptoms: usually uniform on all plants
  - No progression of symptoms (noninfectious)

- **Declines** (Biotic and Abiotic factors cause)
  - Symptoms: usually from interchanging biotic and abiotic agents
  - Stress initiates (drought, cold, heat, etc.)
  - May not recognize original cause unless know history of problem
    - Environment, fungi and insects may be involved
  - "Disease complexes"


Late blight


Leaf scorch


Forest Decline

Causal Agents of Plant Disease

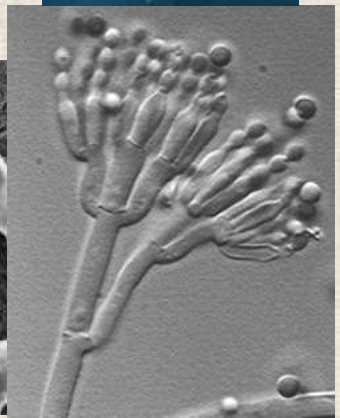
- Pathogenic organisms
  - Fungi
    - Cause 70-80%
  - Bacteria
  - Nematodes
  - Parasitic plants
  - Algae and protozoa
- Noncellular Pathogens
  - Viruses
  - Viroids



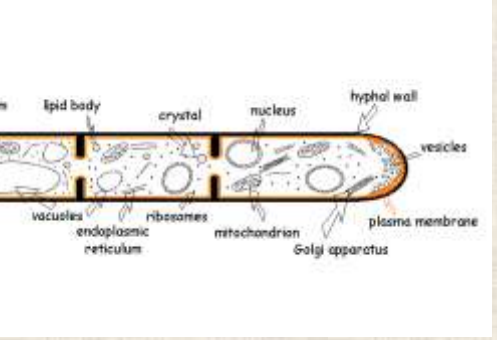


Fungi Come in Two Sizes

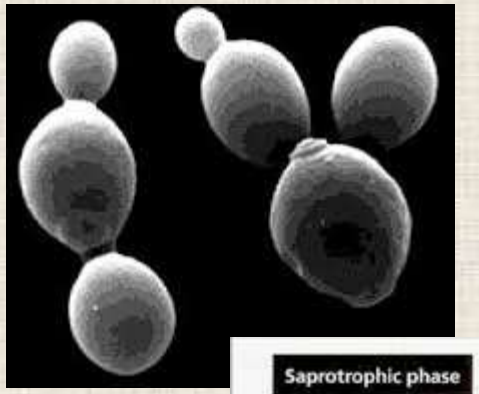
- Macroscopic
  - Mushrooms, bracket fungi, puffballs, etc.
  - Fruiting body visible, spores microscopic
- Microscopic
  - Yeast, molds, zygote fungi, cytrids
  - Fruiting body details and spores microscopic

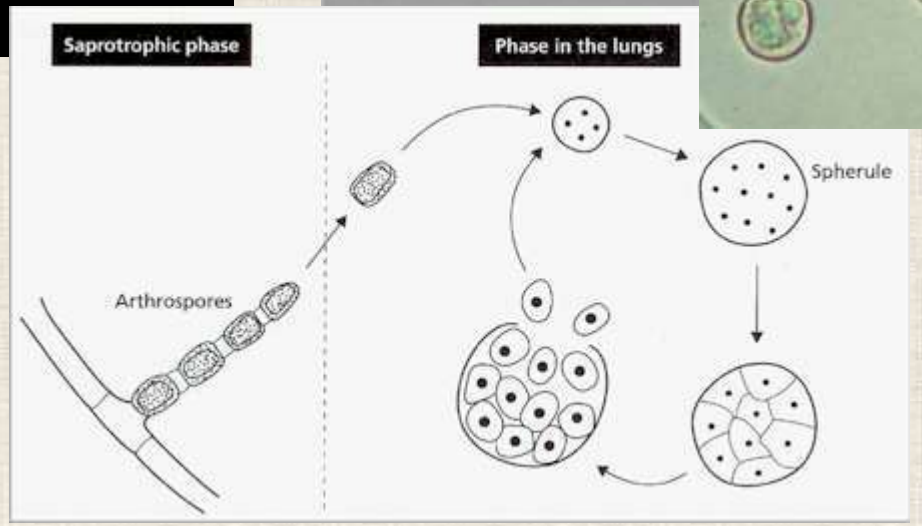


Somatic (Non-reproductive) Structures do the Work!



- Absorption
  - Excrete enzymes into environment
  - Take up nutrients dissolved in water
- Molds
  - Hypha (ae)
    - Mycelium
- Yeast
  - Single cells
  - Budding
  - Fission
  - Pseudohyphae
- Dimorphic fungi
  - Valley Fever

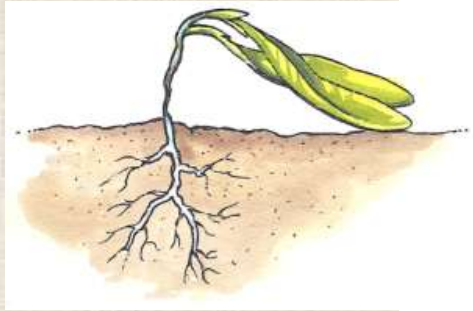


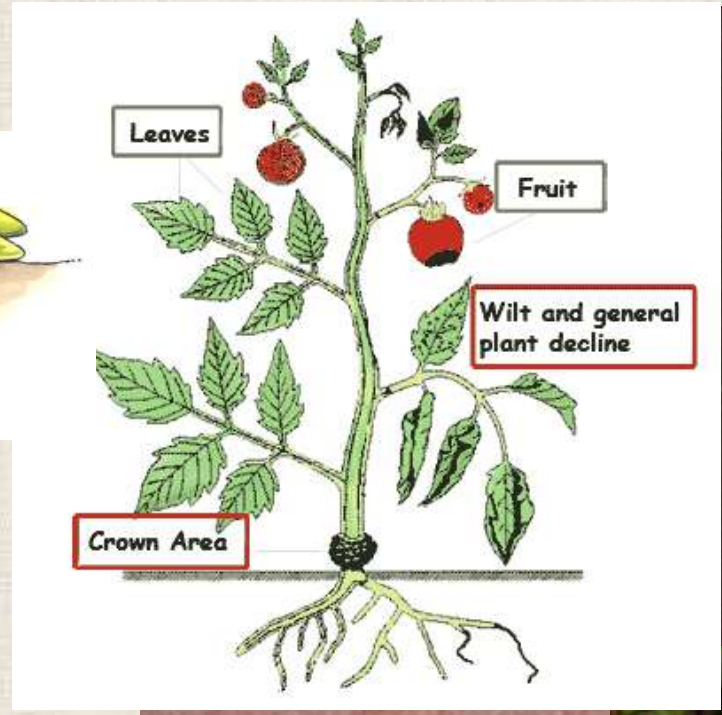


Fungi can Grow on all Plant Parts

- One or more species specific for ever plant
  - Over 100,000 species described, probably over 1 mil. exist
- Leaves (Mildews, leaf spots, anthracnose, etc.)
- Branches and trunk
  - Cankers
  - Heart rot
  - Damping-off
- Roots
  - Rots
- Fruits and seeds
  - Rots, spots, etc.
- Rust diseases
  - Foliar
  - Stems - cankers, galls, witches brooms

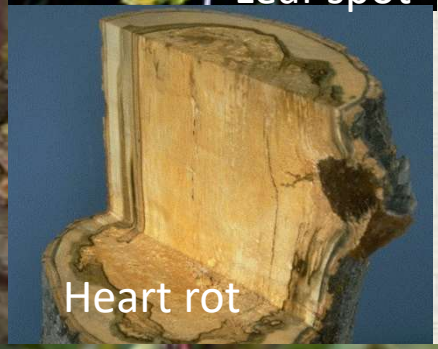

Powdery mildew






Canker


Leaf spot

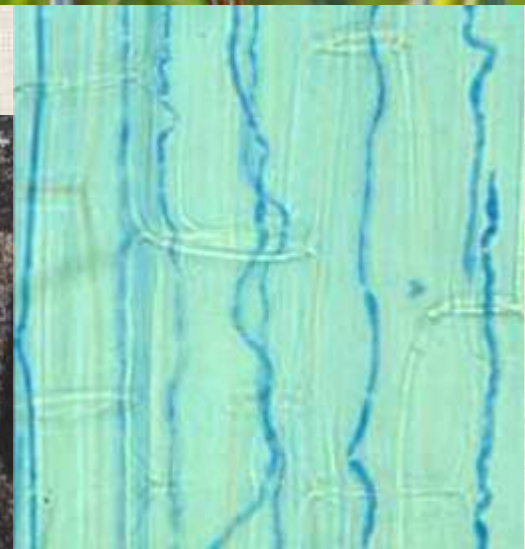

Heart rot


Early Blight


Cedar-apple rust

Fungi in our Gardens

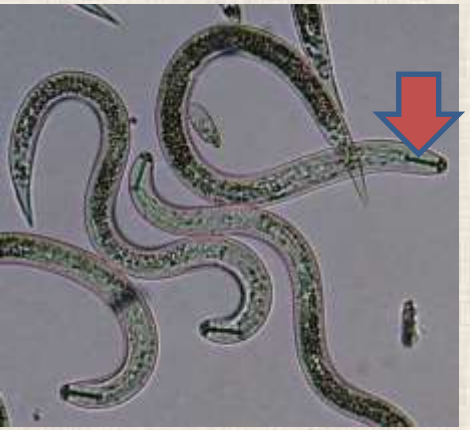
- Decomposers
  - Organic debris
  - Soil fertility
    - Nutrient cycling
  - Compost making
- Pathogens
  - Plants
  - Insects, nematodes, weeds, other fungi (biocontrol)
- Symbionts
  - Mycorrhizae
  - Lichens
  - Endophytes



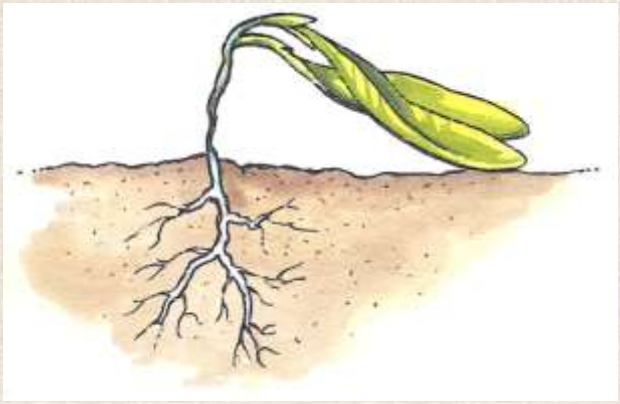
Bacteria

- ~100 species cause plant diseases
  - Pathovars (strains) specific for host cultivars
- Most bacterial plant pathogens
  - Rod-shaped cells
  - All lack nuclear membrane (Prokaryotes)
  - Order of magnitude smaller than our cells
- Many symptoms
  - Galls, blights, cankers, leaf spots, etc.
- Xylem and phloem invading bacteria
  - Infect vascular system
  - Leaf scorch, plant decline, etc.

Other Biotic Agents

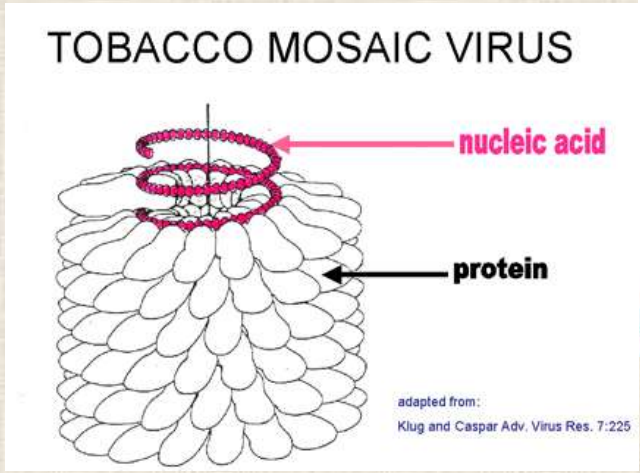


- Nematodes
  - Small round worms related to pin worms
  - Root knot, cyst, dagger, etc.
  - Stylet pierces plant cells
- Parasitic plants
  - Mistletoe, dodder
  - Dodder can transmit viruses
- Algae and protozoa
  - Once only tropical
  - Can cause
    - Root rot
    - Damping off
  - Zoospores infect



Viruses and Viroids


Potato Tuber Spindle Viroid
With T7 bacteriophage DNA




Curly Top Virus


beet leafhopper


CTV

- Viruses
  - DNA or RNA surrounded by protein
  - most plant viruses are RNA viruses
  - Vectors
    - Insects
      - » aphids, white flies, hoppers, thrips, beetles
    - Mites, nematodes, plasmodiophorids
  - Disease Symptoms
    - Leaf yellowing (whole leaf or pattern of stripes or blotches)
    - Leaf distortion (e.g. curling)
    - Other growth distortions
      - » stunting of the whole plant, abnormalities in flower or fruit formation
- Viroids
  - Infectious single stranded RNA
    - Inhibit plant manufacturing of proteins
    - Causes stunting and distortion


PTSV

Common Local Diseases and Pests

- Abiotic Diseases
  - Can affect all types of plants
- Biotic Diseases and Pests
  - Vegetables
  - Fruit Trees
  - Succulent perennials
  - Trees and Shrubs
- Verde Valley Diseases
  - Texas (Cotton) Root Rot
  - Curley Top Virus

Abiotic (Environmental) Factors

- Temperature
  - Extremes
- Soil pH
- Light
- Moisture
  - Excessive, insufficient
  - Drought, flooding, wind, humidity
- Nutrition
  - Deficiencies, excess
- Herbicides Damage
- Lightning Damage
- Air Pollution Damage
- Salt damage
- others


Cold Damage

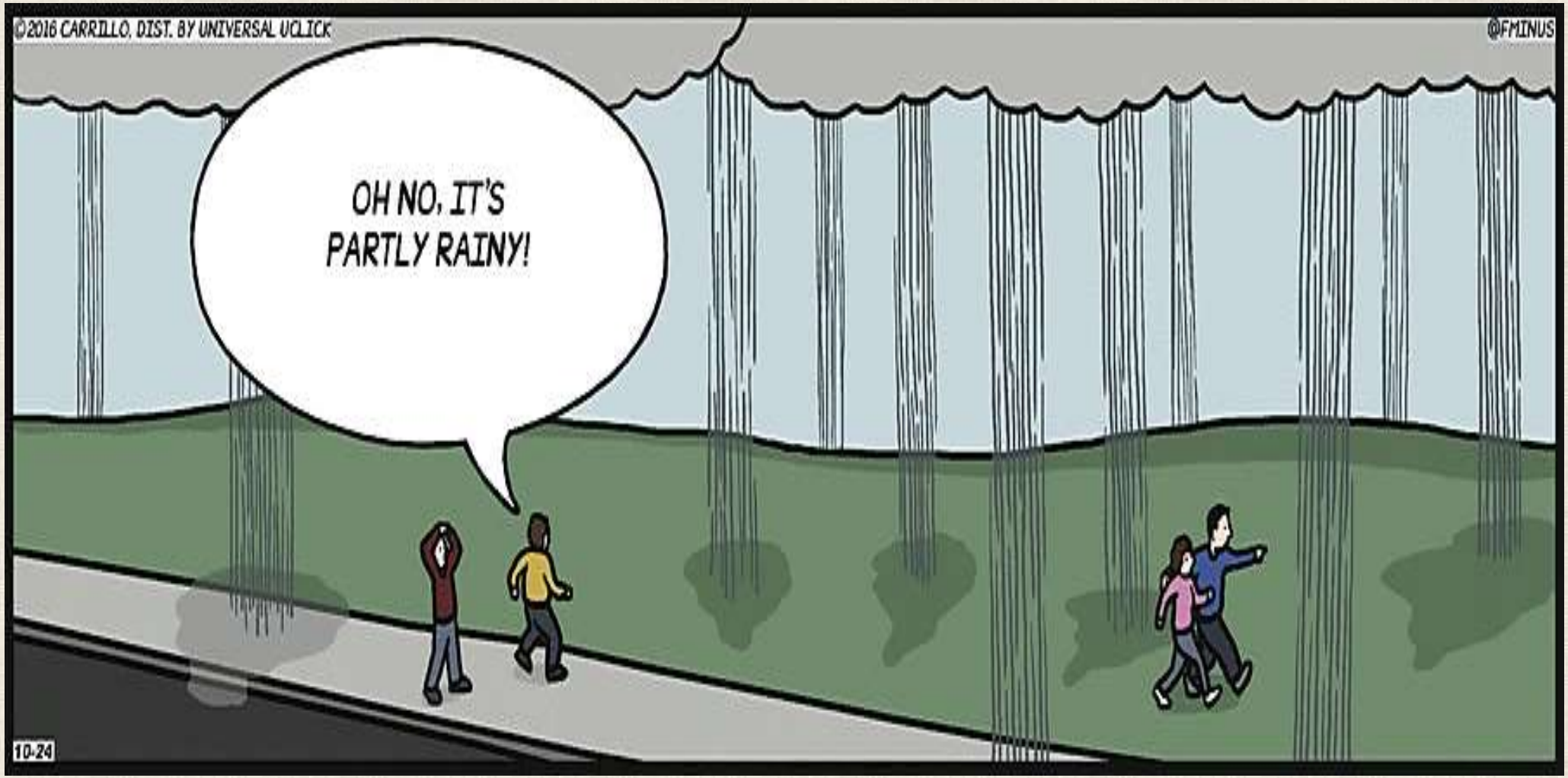

Winter Drying


Lightning


Summer Heat Scorch

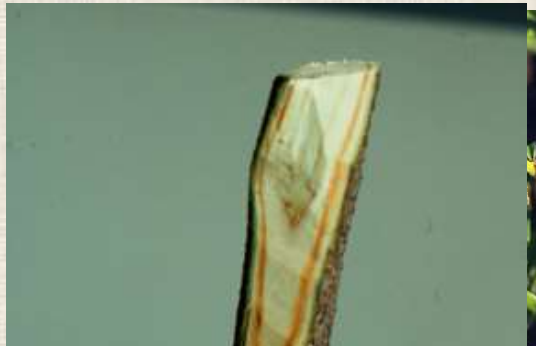

Herbicide Damage
(trifluralin)

Precipitation in Arizona



Tomatoes

- Leaf spots
  - *Septoria lycopersici*, etc.
- Early Blight
  - *Alternaria solani*
- Wilts
  - *Verticillium* spp., *Fusarium* spp.
  - Crop rotation, resistant varieties



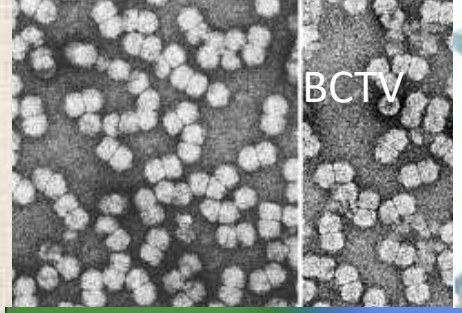

Curly top virus

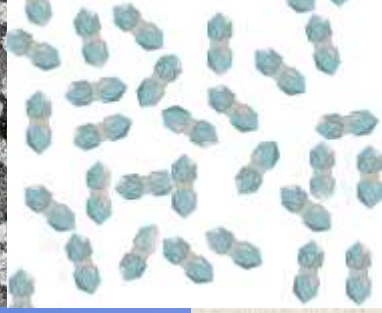
Tomatoes

- Blossom end rot
  - Ca deficiency in fruit
  - Maintain even soil moisture
  - Certain varieties more tolerant
- Diminished pollination
  - Below 55^{o}F or above 90^{o}F
    - Reduced fruit production
  - Need bumble bees (buzz pollination)
- Curly top virus
  - No control available


Wilt

Beet Curly Top Virus





- Hosts
  - » Tomatoes, beans, pepper, spinach, beets, and cucurbits
  - » Many plant species, weeds
- Symptoms
  - » Plants stunted, roots stunted, phloem necrosis, purple leaf veins
  - » Chlorotic leaves curl up, leaf outgrowths
- Vector
  - » Beet leafhopper (*Circulifer tenellus*)
    - wild mustard, Russian thistle
- Prevention
  - – attention to planting date
  - – breeding resistance mostly unsuccessful
  - – weed and insect management, netting
  - – destroy infected plants

Squash


Blossom end rot


Powdery mildew

- Blossom end rot
- Pollination problems
  - Separate female and male flowers
- Mildews
  - Powdery, downy
- Insects
  - Squash bugs
  - Vine borers
- Wildlife
  - Lesser goldfinch
    - Squash, rhubarb and sunflower


Squash bug


Moth


Vine borers


Lesser gold finch damage on sunflower

Powdery Mildew

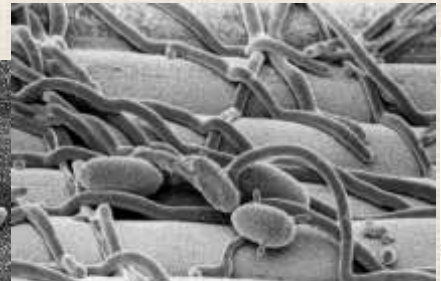
- Foliar diseases of many different plants
  - Fungal species usually very specific to a plant species or group
  - Prevention
    - Resistant cultivars
    - Early applications of specific fungicides
  - Tolerated – usually not controlled

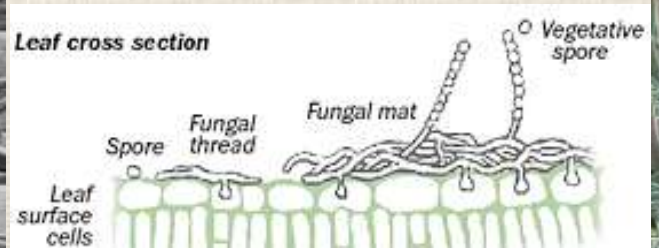
Powdery Mildew of Cucurbits

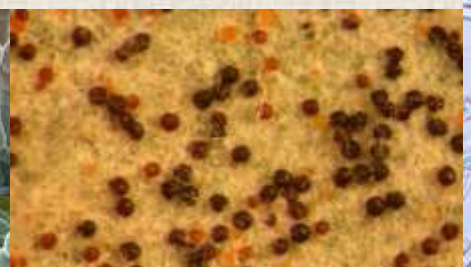
Vegetablemdonline.ppath.cornell.edu/factsheets/Cucurbits_PM.htm

- Hosts
  - Cucumbers, melons, pumpkins, squash
    - most susceptible
      - 16-23 days after leaves unfold, after fruit initiated, dense growth, low light
      - susceptible cultivars (lack wild cucurbit resistance genes)

- Pathogens
  - Powdery mildew fungi, airborne conidia (spores)
    - *Podosphaera xanthii*, *Erysiphe cichoracearum* (most common)
    - Host specific, survive winter on plant debris
- Environmental conditions
  - 69-80^{o}F most favorable, 50-90^{o}F infection range, stops at ≥100^{o}F, 50% RH or higher, dry leaf surface favorable, wet unfavorable
- Time
  - Symptoms 3-7 days after infection





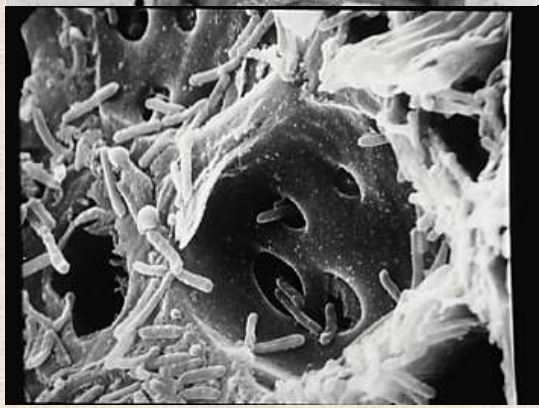


Fruit Tree Diseases caused by Bacteria

- Fireblight
  - Pears, apples, other members of rose family
  - Leaf blight extends to branches and trunk
  - Cankers may girdle branches and trunk
- Crown gall
  - Fruit trees, grapes, roses, most plants
  - Woody galls on the upper roots, crown, branches
  - Usually comes with the plant from nursery

Fastidious Vascular-Colonizing Bacteria

- Vascular-feeding insect vectors introduce
  - Leaf hoppers, plant hoppers, psyllids, squash bugs
- Most other bacteria use natural openings or wounds
- Live in phloem sieve tubes or degenerated xylem elements
  - 1) Phytoplasmas and spiroplasmas - >600 yellows diseases
  - 2) Fastidious phloem colonizing bacteria (Ash Decline, etc.)
  - 3) Fastidious xylem-limited bacteria, *Xylella fastidiosa*
    - » (Pierce's Disease of Grapes) + 75 other host plants
- Many plant hosts are symptomless
- Some FVCBs live and reproduce in insect vector
- Stress may make plants more susceptible



PLANT	DISEASE
Grapevine	Pierce's disease
Citrus	Citrus variegated chlorosis
Oleander	Oleander leaf scorch
Almond	Almond leaf scorch
Oak	Oak leaf scorch
Sycamore	Sycamore leaf scorch
Alfalfa	Alfalfa dwarf
Peach	Phony peach

Ash Decline (Ash Yellows)

- Symptoms
  - dead and dying branches
  - new tufts of foliage (“witches brooms”) reduced in size emerges from lower branches
  - previous two or three year’s growth greatly reduced
  - trees may die
- Host trees in Arizona
  - Arizona ash (*Fraxinus velutina*) - native
  - Modesto ash (*F. velutina* ‘Modesto’)
  - Raywood ash (*F. oxycarpa*) - possibly
- Pathogen
  - bacterium (*Candidatus fraxinii*) invades phloem
  - insects possibly may transmit
- Reference
  - Backyard Gardener -Jun 27, 2012
    - ”Ash Decline in Yavapai County”

Succulent Perennials

- Diseases
  - Agave anthracnose
  - Phillosticta pad spot
- Pests
  - Agave and yucca weevils
  - Cochineal scale

Trees and Shrubs

- Leaves
  - Mildews, leaf spots, anthracnose, etc.
  - Aphids, scale, spider mites, etc.
- Branches and trunk
  - Cankers
  - Heart rot
  - Borers
  - Crown gall
- Roots
  - Rots
  - Root knot nematode

Bacterial Wetwood and Slime Flux

- Hosts
  - Elms, mulberry, and other wounded trees
- Cause
  - Bacteria grow in the bark and sapwood
    - Smelly discolored liquid flows down branch or trunk
      - Bacterial fermentation products
      - Soil bacteria enter injury above or below soil line
        - » Natural cracks, pruning cuts, etc.
    - Will not kill the tree, more a nuisance
- Treatment
    - Usually no treatment, wait for wound healing
    - Pruning and drainage tubes <u>not</u> recommended

Cotton (Texas) Root Rot

- Hosts
  - Many different trees, shrubs, vines and perennials (over 2,300 host plants)
- Pathogen
  - Fungus - *Phymatotrichopsis omnivorum*
- Distribution
  - Southwest USA and Mexico
  - Low desert areas and elevations up to 5000 ft
  - Verde Valley but <u>not</u> Prescott

Dead peach tree with leaves attached

Cotton Root Rot

- Symptoms and Signs
  - Sudden wilting
    - during the summer when temperatures are high
  - Dead or dying foliage remain attached to plant
  - Roots rotted and brown in color
    - Strands of fungus grow on root
  - Fungal mats found on soil surface




Cotton Root Rot

- Treatment
  - rarely successful
  - therefore not recommended
  - plant immune or highly resistant species in infested areas
- Replanting
  - monocots are immune
    - use yuccas, grasses
    - hardy palms in mild locations
  - pines are very tolerant

- http://ag.arizona.edu/pubs/diseases/az1124/#prr
- http://ag.arizona.edu/pubs/diseases/az1150.html

Dead peach tree with leaves attached

Cytospora Canker

- Hosts
  - Aspen, cottonwood, other stressed deciduous trees
    - Orange spore masses develop in moist conditions
    - Branches and trunk girdled
    - Do not plant riparian or high elevation trees in dry habitats
- Pathogen
  - Fungus - *Cytospora chysosperma*

Aspen Diseases and Problems

- Environmental stress problems
- Foliar Diseases, Cytospora canker
- Heart Rot (*Phellinus tremulae)*
- Deer rubbing bark

Seiridium Canker

- Hosts
  - Leyland, Italian, and Monterey cypress
- Fungal Pathogen
  - *Seiridium cardinale*
    - Girdles - twigs, branches, and trunk
    - Foliage - dies
    - Cankers
      - Multiple vertical cracks
        - » Resin flows
        - » Black spots (fruiting bodies) at edge
    - Diagnose from characteristic <u>spores in resin</u>
      - (Backyard Gardener - Aug 10, 2011)

Local Rust Diseases

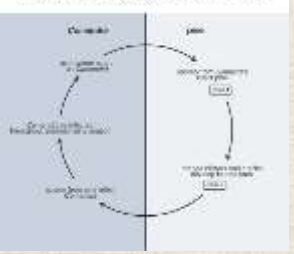

Cedar-apple rust


Rust on wildflower


Black stem rust


Rust on milkweed


Comandra rust



Comandra Blister Rust

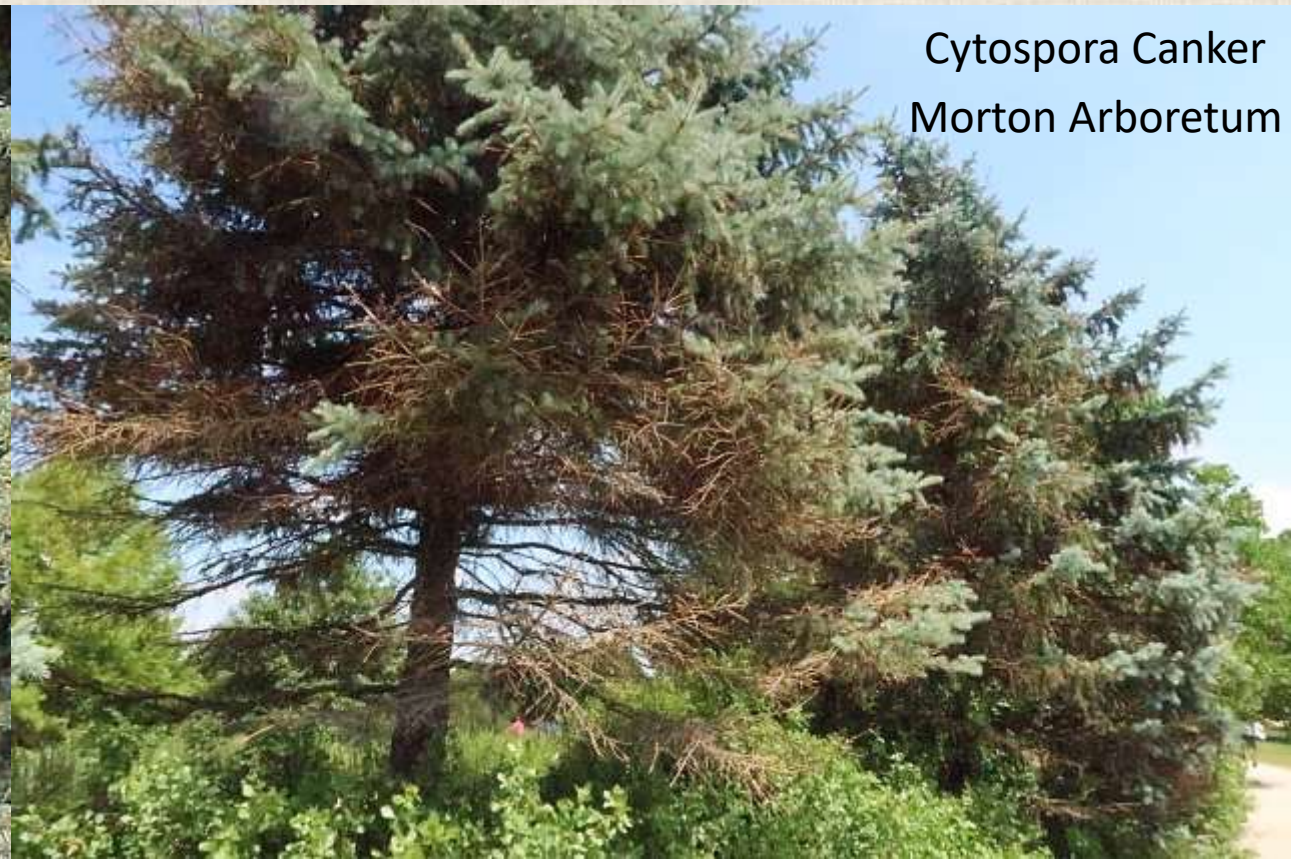
Cronartium comandrae

- *Pinus brutia varieties*
  - Mendel, Eldarica, Eldar, Afghan, Turkish, Aleppo etc.
  - also Ponderosa pine, Lodgepole
  - Economically important host
    - “blisters”, branch and trunk gurdling

- Bastard toadflax (*Comandra pallida)*
  - Alternate host
    - Hemiparasite on oak roots
    - root parasite on oaks

Colorado Blue Spruce

- Yellow needles, needle drop
- High elevation tree grown on warmer and drier sites
- Stress from less moisture and higher temperatures

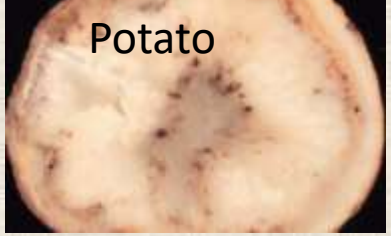


Cytospora Canker
Morton Arboretum

Galls on Manzanita

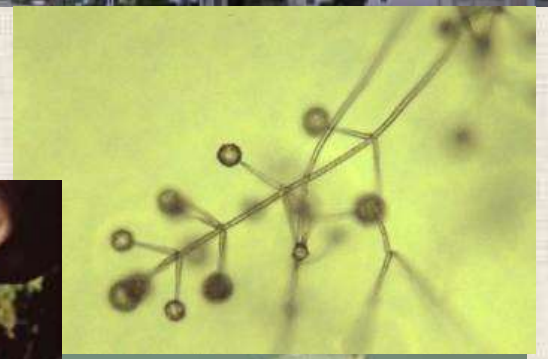
Fungal Leaf gall (*Exobasidium vaccinii)*

Leaf Gall Aphid
(*Tamalia coweni*)



Verticillium Wilt

- Hosts
  - 300 species of dicot plants
  - Tomatoes, potatoes, maple, etc.
  - Soil fungi
    - Verticillium *dahliae*, *V. albo-trum* and *V. longisporum*



Plant Parasitic Nematodes

- Root-knot nematode
  - swellings in the roots
    - interfere with the flow of nutrients and water
    - Feed with stylet
  - most vegetables, bedding plants, many trees and shrubs
  - impossible to eradicate
  - introduced with plants and soil

Parasitic Flowering Plants

True Mistletoes

- *Phoradendron* spp.
  - Common on hardwoods: oaks, sycamores, cottonwood, mesquite, *Acacia* spp., palo verde; also juniper, cypress, white fir
  - Lower elevations
- Limited damage to host
- Birds distribute seed

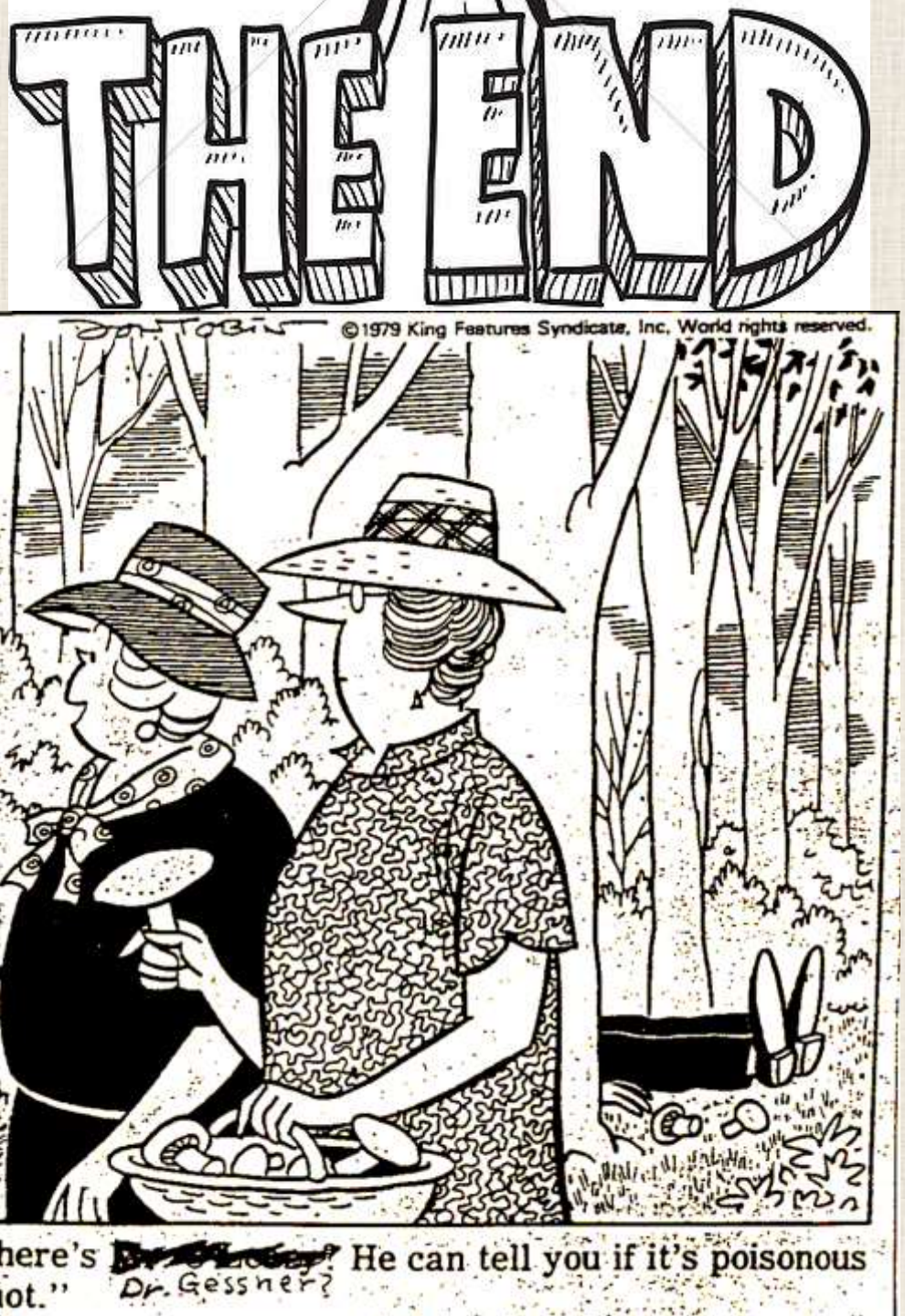
Dwarf Mistletoes

- *Arceuthobium spp.*
  - Common on pines, cypress
  - Higher elevations
- Can severely debilitate or kill host
- Forcibly discharge seeds (52ft)

Dodder

Some Yavapai County Plant Pathology Principles

- Do not use plants from:
  - Riparian areas in hot dry landscapes
    - Cottonwood, Sycamores, Willows, etc.
  - High elevation - cooler and moister environments
    - Colorado Spruce, Douglas Fir, Aspen, etc.
- Do not plant:
  - Invasive plants
    - Siberian Elm, Tree of Heaven, Russian Sage, etc.
  - Leland Cypress
    - Dies from Seiridium canker
  - Some Problem Plants
    - Ash, Eldarica Pine group, Ponderosa Pine (road salt) Pinyon Pine, etc.


THE END
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"Where's [illegible] Dr. Gessner? He can tell you if it's poisonous or not."

Plant Diseases, Pests and Problems

DISEASES

Caused by fungi:
Verticillium wilt – wilted leaves, dicolored vascular tissue, flagging branches
Seiridium canker – dead branches, cracks and cankers in bark with resin, characteristic spores
Comandra rust- wildflower hemiparasite od oak roots, stem cankers on *Pinus eldarica*
Leaf spots - self-limiting usually circular lesion on leaf
Ganoderma butt and root rot - infection occurs at wounds, white-mottled rot is usually concentrated in large roots and basal area of trunk, fruiting bodies called conks may be present
Cytospora canker – necrotic often sunken lesion on stem, branch, or twig; occurs in stressed trees
Blue stain – caused by microscopic fungi, infect sapwood, do not cause decay, stain wood blue or gray
Heart rot – decay in the center of the trunk of a living tree
Juniper rust - bright red and orange leaf spots and orange gelatinous galls are formed on different hosts
Corn smut - galls on all above-ground parts of corn species

Caused by bacteria:
Crown gall - tumor-like growth or gall on the infected plant, often at the junction between the root and the shoot
Fire blight – rapid killing of leaves flowers and stems, pears most susceptible, occurs in rose family

Caused by nematodes:
Root knot nematode - nematode larvae infect plant roots, causing the development of root-knot galls

Caused by parasitic plants:
Leafy mistletoe - dieback, swelling, formations of witches' broom and weakened branches on hardwood trees
Dwarf mistletoe - have very reduced shoots and leaves, parasitize members of pine and cypress families
Dodder – yellow spaghetti-like growth on host plant, twines around stems, has reduced leaves, morning family

INSECT PEST PROBLEMS

Flat head borer damage - wood borer beetle larvae tunnel into wood
Twig galls - simple bumps, fruit-like structures or complicated growths caused insects, mites, nematodes, fungi, bacteria, or viruses
Bagworms - construct cases out of silk and environmental materials, feed on plant leaves
Gall wasp damage - induce galls on plants for larval development
Tent caterpillars – moth larvae secret silk tents on branches, feed on leaves

WILDLIFE DAMAGE

Sapsucker damage - neat rows of ¼" holes
Pocket gopher damage - in-ground holes lead to below ground burrow, mounds of soil the burrowing process and deposited around the gopher hole, feed on plant roots, chew marks may be present on large roots and stems
Rabbit damage – eat succulent tissue, can eat bark and girdle woody plants
Deer damage – rub bark or eat leaves and twigs

OTHER PROBLEMS

Fasciation - abnormal growth in the apical meristem (growing tip), becomes elongated perpendicularly to the direction of growth, producing flattened, ribbon-like, crested, or elaborately contorted tissue; possible causes include hormonal, genetic, bacterial, fungal, viral and environmental causes.

Some Plant Pathology Principles

- I - Disease is a malfunctioning of a plant, which results from a continuous irritant by a pathogenic agent.
- II - Disease results from an interaction of the virulence of the pathogen, susceptibility of the host, and the conduciveness of the environment.
- III - Conditions which favor plant growth and health commonly favor disease.
- IV - Overwatering and underwatering plants can increase disease.
- V. The realistic way to manage plant disease is through an integrated management strategy that includes: 1) cultural practices, 2) epidemiology, 3) resistant varieties, 4) chemical pesticides, and 5) biological control.

Plant Pathology Principles

- VI - A major approach to disease control is inoculum reduction.
- VII - Wood decay organisms result in wind damage and breakage in trees.
- VIII - Epidemics of introduced (invasive) species are more severe than epidemics of endemic species.
- IX - Quarantine is often the best method for combating disease.
- X - Do no harm.

- John A. Menge and Elinor Pond
- Department of Plant Pathology
- University of California, Riverside
- http://ceventura.ucanr.edu/Environmental_Horticulture/Landscape/Problems/Pathology/

"From Apples to Popcorn, Climate Change Is Altering the Foods America Grows"

"In every region, farmers and scientists are trying to adapt an array of crops to warmer temperatures, invasive pests, erratic weather and earlier growing seasons". Kim Severson, April 30, 2019 nytimes.com

https://www.nytimes.com/2019/04/30/dining/farming-climate-change.html

Michigan -Tart cherries – fruit flies
New York - Organic raspberries – fruit flies
Florida – Watermelons – earlier and longer season, overlaps with Mexican competition
Montana – Chickpeas – will plant more instead of wheat as a hedge against heat and drought
Maine - Wild Blueberries – record high temperatures, erratic frost
Iowa - Organic Heirloom Popcorn - unpredictable spring rains uneven summer heat
Georgia and South Carolina – Peaches - unpredictable frosts, not enough chill hours
Washington - Organic Apples - hotter spring weather, increase in diseases like fire blight
Texas - Golden Kiwi Fruit - chill hours and freezes
California – Artichokes – artichoke plum moth, production moving 450mi south
Arkansas – Rice - less rain, higher temperatures

Abiotic or Biotic Disease?

What are the possibilities?

- Abiotic problem
  - Hail damage
- Biotic disease
  - Caused leaves to drop
- Non-disease problem
  - Insect defoliation
    - Tomato horn worm, blister beetles
- Vertebrate animal grazing
  - Rabbits, pack rats, ground squirrels, javalina, deer, etc.

Vertebrate Animal Grazing

Vertebrate Animal Grazing

Science is not perfect but -

the scientific method is the best method we have for answering questions about the natural world!

Lots of scientifically unproven myths and dogmas about horticultural topics in the local folklore.

Science Can't Solve Everything!

Pollinators

Koch's Postulates:

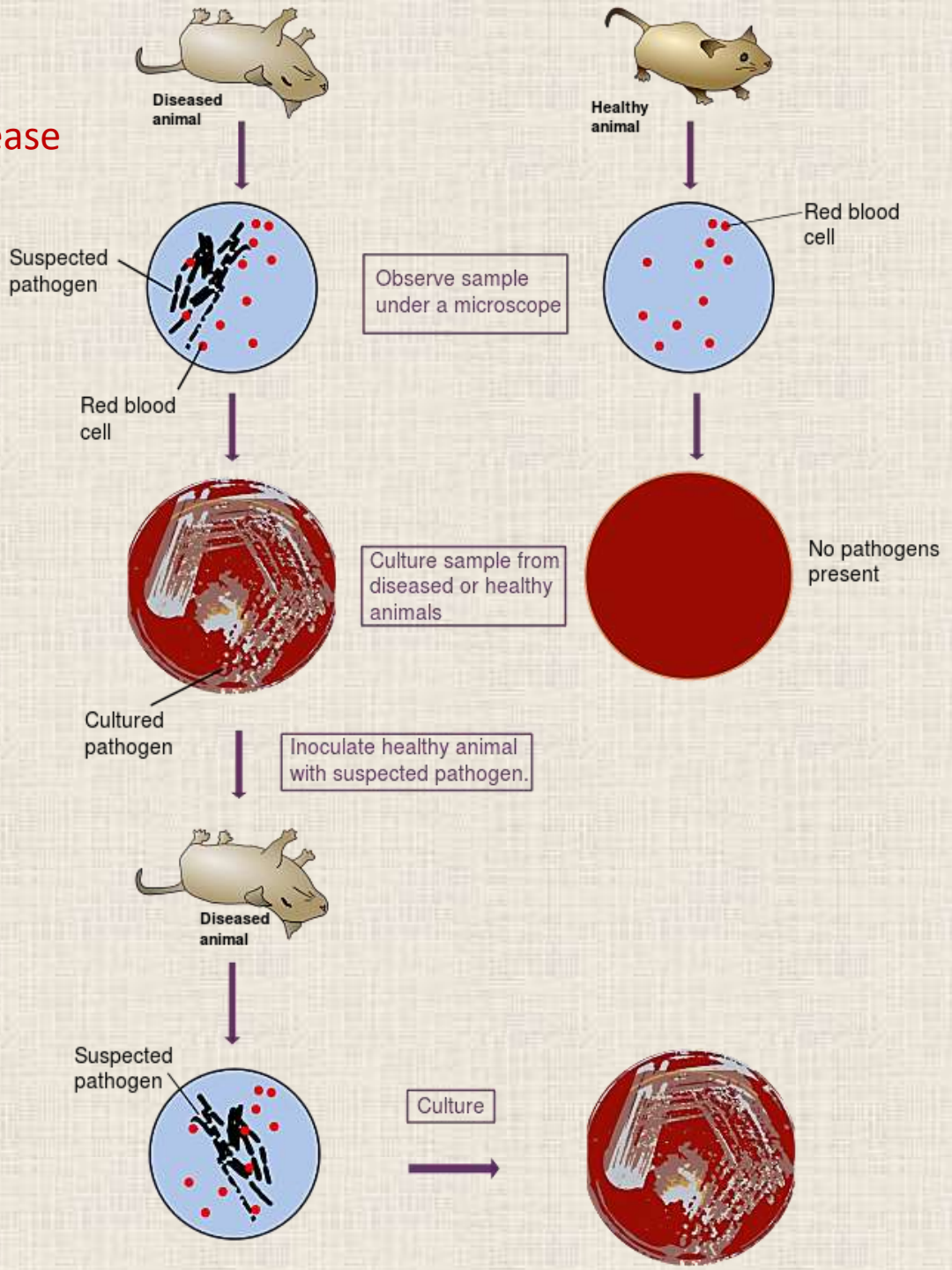
Proof That An Organism Causes Disease

① The microorganism must be found in abundance in all organisms suffering from the disease, but should not be found in healthy organisms.

② The microorganism must be isolated from a diseased organism and grown in pure culture.

③ The cultured microorganism should cause disease when introduced into a healthy organism.

④ The microorganism must be reisolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent.



Additional Resources

- Plant Disease Diagnosis
  - https://www.apsnet.org/edcenter/disimpactmngmnt/casestudies/Pages/PlantDiseaseDiagnosis.aspx
- Plant Pathology Principles
  - http://ceventura.ucanr.edu/Environmental_Horticulture/Landscape/Problems/Pathology/
- Climate Change and US Crops
  - https://www.nytimes.com/2019/04/30/dining/farming-climate-change.html
- Crop Losses From Disease and Pests
  - https://agfax.com/2019/01/25/farming-weather-is-leading-cause-of-u-s-crop-loss-how-do-you-assess-the-risk/
  - https://www.statista.com/statistics/272493/revenue-of-the-plant-protection-market-worldwide-since-2007/
  - https://www.marketsandmarkets.com/PressReleases/crop-protection.asp
- Cotton Root Rot
  - http://ag.arizona.edu/pubs/diseases/az1124/#prr
  - http://ag.arizona.edu/pubs/diseases/az1150.html