PLANT PATHOLOGY

by

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WHAT IS PLANT PATHOLOGY?

- Definition: the science that deals with the nature and control of plant diseases.
- Can include mycology, bacteriology, plant physiology, nematology, entomology, virology and more.

Plant Pathology: The Study Of Plant Disease

A combination of **SCIENCE** and the **APPLICATION OF SCIENCE**

Comes from the Greek: **PATHOS** (suffering) and **LOGOS** (study)

A. Living things and environmental conditions that cause plant disease.
   1. What sorts of things cause disease?
   2. Why don't all plants die?

B. The ways the environment and living organisms interact to cause plant diseases.
   1. How do plants get infected?
   2. What type of weather makes disease worse?

WHAT IS PLANT DISEASE?

A process by which living or non-living entities interfere, over a period of time, with a plant's function.

Application

- Recognizing and diagnosing disease and conditions that cause disease.
- Methods of managing plant diseases and reducing the damage they cause.

Plant Disease Indicators

- Smaller leaves
- Fewer leaves
- Smaller root system
- Shorter internodes
- Smaller or fewer fruit
- Blemished plant parts
- Death of plant parts

More On Disease

- The change in a plant's appearance is relative to a plant of the same age and variety that is not diseased.
- Therefore, one must know what the plant normally looks like before determining that it does or does not have a disease.
- Visible changes = symptoms

Healthy vs. Diseased

- Disease causes changes in a plant's structure and function.
- Important physiological functions of a healthy plant include…
  1. Photosynthesis
  2. Absorption of water and minerals
  3. Translocation of food, nutrients, and water through xylem and phloem
  4. Production of different tissues via cell growth and development

Healthy vs. Diseased

(Continued)

5. Production of flowers, seeds, and/or tissue for vegetative reproduction.
6. Storage of nutrient reserves.

In general terms, this means that a plant is not looking like we want it to, not growing as well as we want it to, and not producing the products we want it to produce.

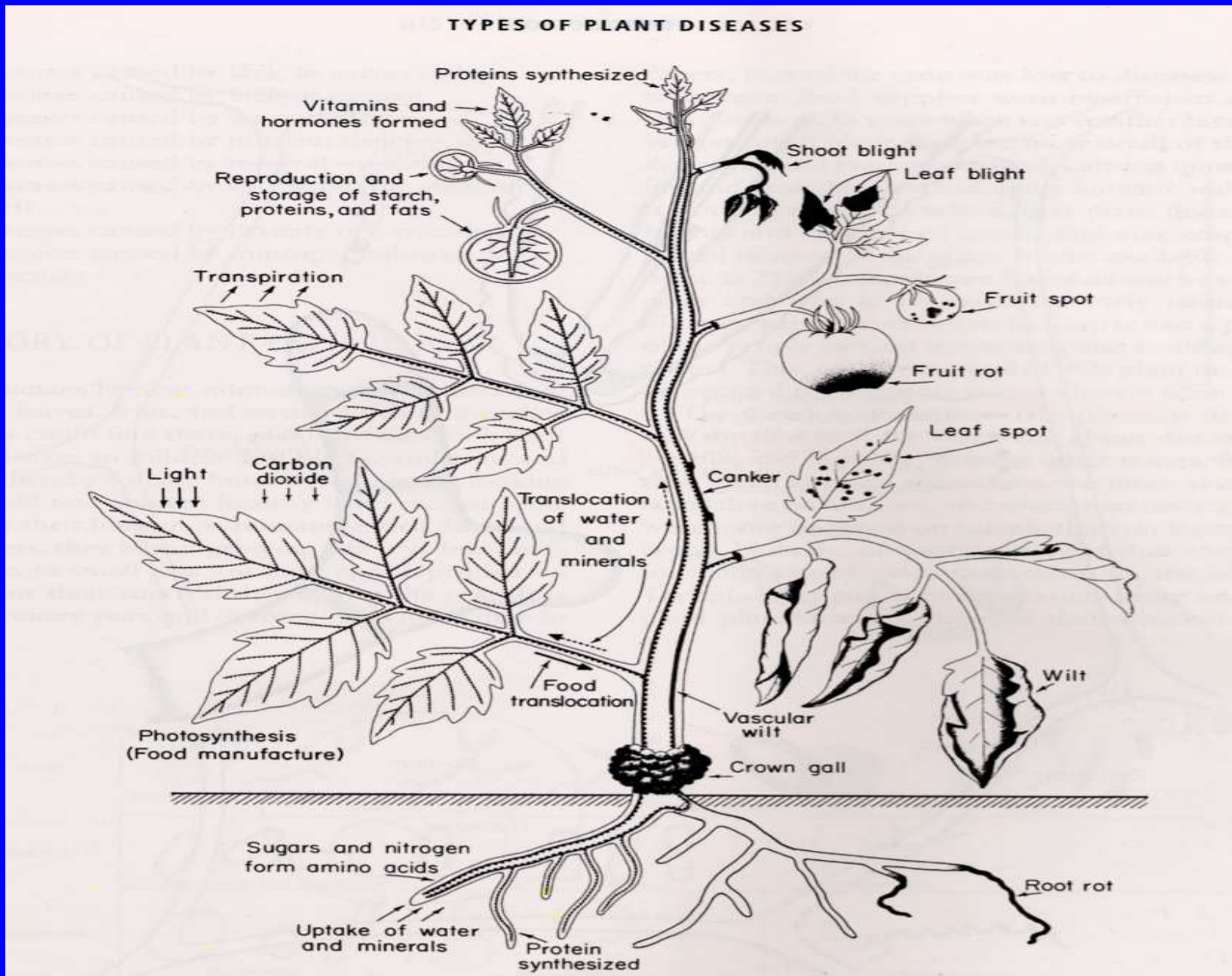


FIGURE 1-1 Schematic representation of the basic functions in a plant (left) and the interference with these functions (right) caused by some common types of plant diseases.

Types of Disease

- Can be grouped according to their symptoms- examples – rots, wilts etc.
- Grouped according to the organs they affect. Examples- root diseases, stem diseases etc.
- Grouped according to the type of plant affected- examples- field crop diseases, vegetables diseases, turf diseases.

Causes of Disease

BIOTIC….. Or infectious/living

Fungi, bacteria, viruses, nematodes and parasitic plants.

ABIOTIC….. Or non- infectious non-living/cultural

environmental- temp, soil moisture, light, pollution, chemical injury, etc.

History of Plant Pathology

- Theophrastis(300 B.C)- Greek Philosopher- first to study and write about diseases of trees, cereal and legumes.
- Romans- a god controlled the weather that brought about the disease
- Avoidance of disease depended on doing things that pleased the gods.
- Created Robigo, a special rust goddess to keep disease off of their cereals and grains.

More History

- 1600- invention of the compound microscope. Scientists were able to see disease-causing organisms and moved away from the theory that disease was a direct act of the gods.

Still More History

- 1700- Farmers in France noted alternate host of rust on barberries (grain rust).
- 1777- Scientist Tillet- worked with the spread of spores on infested plants.
- 1807- Prevost showed that spores were capable of germinating –this showed signs of life. Everyone thought he was nuts!
- 1845-1851- Irish Potato Famine- Caused scientists to finally take a closer look at plant pathogens.

Yes- Still more History

- 1861- Scientist DeBary- put a name to the fungus that caused the potato blight- *Phytophthora infestans*- and worked extensively on proving that a fungus was responsible for the disease on the potato. He is called the father of plant pathology.
- 1861-1875- Pasteur worked with Koch on isolating the bacterium that causes anthrax.
- Koch developed and introduced techniques for growing organisms in culture. These four steps called Koch's postulates provide proof that isolated organisms from a diseased plant are the cause of the disease. These techniques are still used today.

From www.nobelprize.org

Why is this Important?

- Plant diseases are important to humans because they damage plants and plant products on which we depend for food, clothing, furniture, the environment and housing.
- Economic plant losses to growers affect consumers.
- Direct effect on humans and animals who consume them.
- Diseased plants destroy the beauty of the environment by damaging plants around the home and forest.
- By controlling these diseases, we release billions of pounds of toxic pesticides that pollute our water and environment.

Ramorum Blight -Formerly Sudden Oak Death

- *Phytophthora ramorum*- first identified in 1993 in Germany and the Netherlands on ornamental Rhododendrons.
- Isolated from dying trees in California and Oregon in 2000 and has moved across the U.S on infected nursery stock.
- *P. ramorum* causes bark cankers that can kill the host and foliar blights that can house the pathogen.
- Wide range of host plants- oaks, blueberry, Rhododendrons, bay laurel, honeysuckle, camellias.
- Confirmed cases in CT in 2004 and 2006 on nursery stock.

Oaks in California infected with Sudden Oak Death

Phytophthora ramorum infection on the leaves of California bay laurel (*Umbellularia californica*)

Photo: Joseph O'Brien, USDA-Forest Service

Case Study
The Irish Potato Famine

- Potato was introduced in Europe in 1500s but most countries also grew other sources of food.
- Rapid rise in Ireland's population prompted farmers to devote more land to growing spuds.
- In war-torn Ireland, peasants had a hard time growing enough food to feed themselves , so the potato became a great crop to grow and their major food source.
- By 1800's most of the country relied on it heavily.
- Major source of nutrition, easy to grow with minimal labor, training or technology. Simple storage.

More On the Potato Famine

- Cheap! An Irish family could live for a year on one acre's worth of potatoes.
- Started to grow one variety the 'Lumper', which was very fertile and had a high yield per acre. (No genetic variation!)
- 1845- Fungal disease- 'late blight' sweeps the Irish country side destroying 40% of the potato harvest.
- Potatoes are stored and next season planted again. Wet weather pattern continues in 1846.
- The potatoes rot in the field resulting in 100% crop loss in 1847.

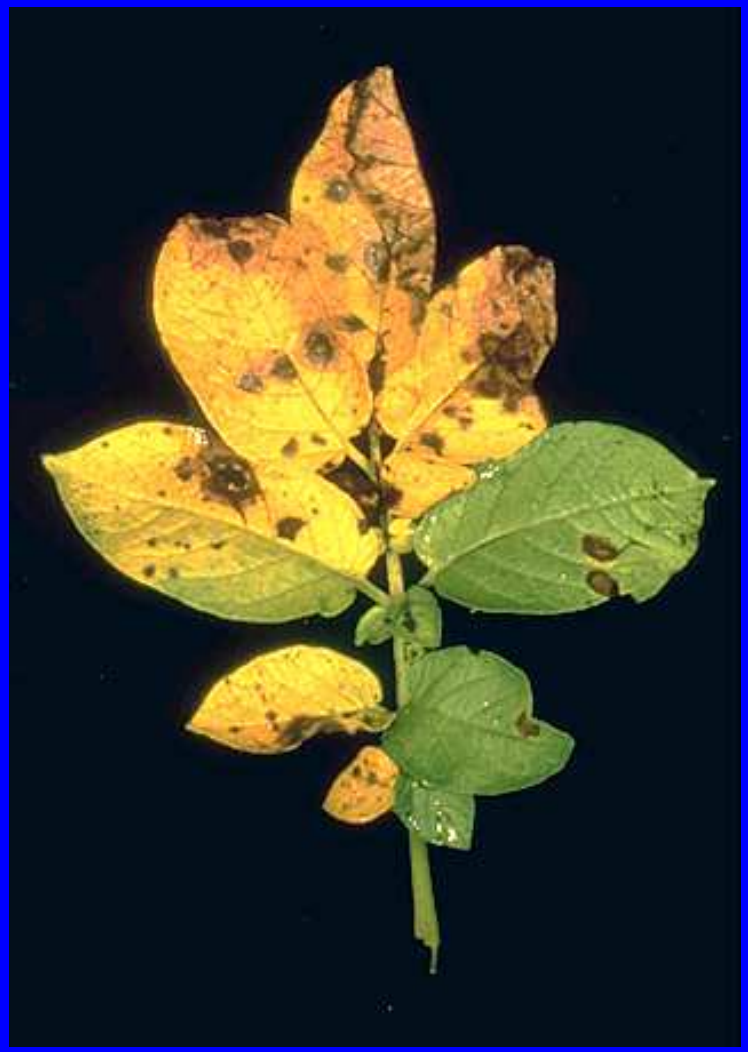
Phytophthora infestans -- Late Blight Organism

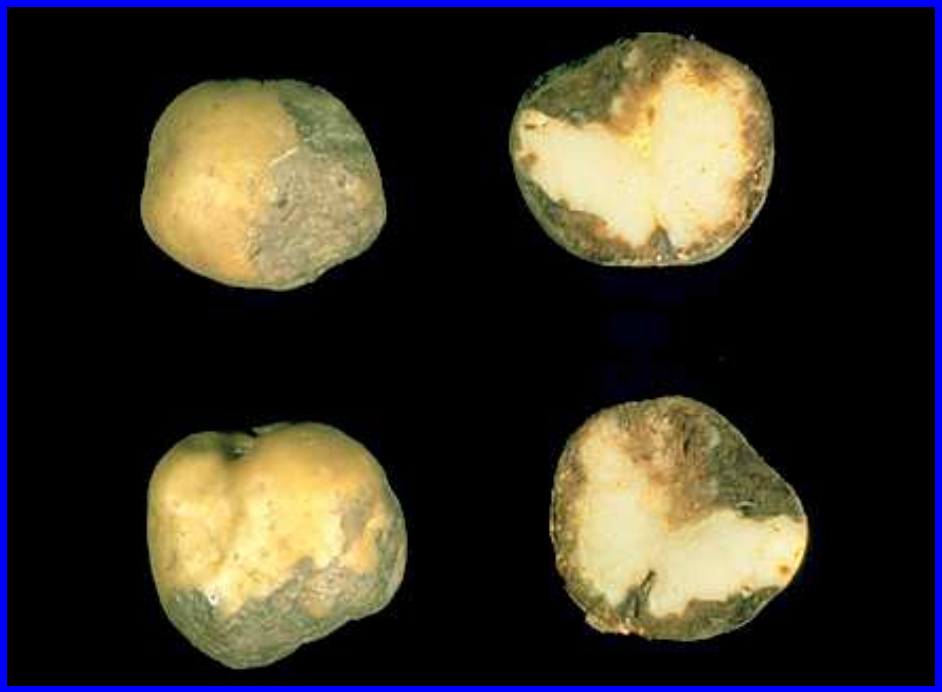
Signs and symptoms:

early symptoms: water-soaked or with chlorotic borders that expand rapidly

Late Blight of Potato

Potato tubers become infected when sporangia are washed from the foliage through the soil. Infections begin in tuber cracks or lenticels. Infected parts of tubers have a reddish to purplish color (left). SPORULATION (RIGHT) on the surface of infected tubers in storage.





Potato tubers displaying symptoms of POTATO LATE BLIGHT

Sporangia and zoospores of *P. infestans* germinate and infect potato leaves causing necrotic lesions and collapse of leaves

More Famine

- Irish peasants had few other options when the crop failed and started to sell off their other crops and possessions to pay the rent.
- As a result of the crop failure, most peasants were forced to leave their homes and wander the country-side. They faced mass starvation and a rapid rise in diseases such as dysentery, typhus, cholera and scurvy from poor nutrition and eating the stored infected potatoes.
- 1847- the disease organism is examined after masses of people have starved to death. A resistant potato variety is planted but the shortage of seed potatoes continues until 1851 when the British make an effort to provide relief to Ireland.

The End Result

- Officially over in 1851, Ireland lost 25% of its population in 6 years. 1.5 million people died of starvation and disease and another 1.5 million emigrated to the United States and Canada. Half of those that emigrated died on the way over in the overcrowded disease-ridden ‘coffin ships’.
- While the blight provided the catalyst for the famine, the problem was increased by economic and political factors, environmental causes and questionable agricultural practices.

The Potato Today

- Still continues to be a major dietary staple in 130 countries including Ireland.
- New strains of that same fungus- *Phytophthora infestans* have been reported in 1980 in Florida and Maine.
- Has since spread. In 1996, Maine lost $25 million in potato revenues.
- New strains possess genetic variations and the fungus spreads faster, can survive harsher weather conditions and are more resistant to chemical controls. Fungal spores can last longer in the soils.
- New blight resistant potato varieties are being developed but it takes time.

What does all this mean?

- The Irish Potato Famine brought about the beginnings of Plant Pathology.
- Scientists examined the potatoes and pathogens quite closely.
- Determined three components that are present when disease occurs.

Hosts vs. Environment

HOSTS

- Have diseases -- the plants that develop a disease. Example: potato
- Hosts can resist disease or be susceptible to disease.
- Most plants have some resistance to disease.

Hosts vs. Environment

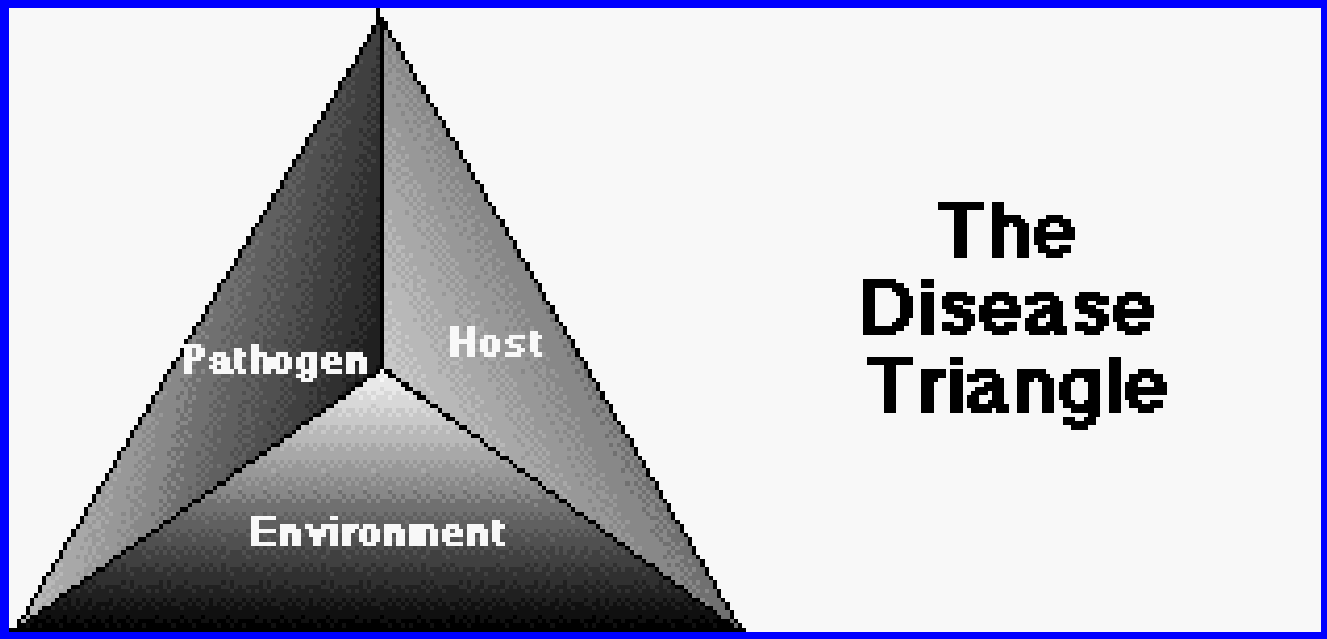
ENVIRONMENT

- Promotes or inhibits disease
- Example: Temperature. May affect the pathogen or the host; may stress or favor either.
- Rapid disease progression requires favorable conditions for the infection and reproduction of the pathogen.

Factors Influencing Disease

- **PATHOGEN:** The abundance and aggressiveness of the organism causing the disease.
- **HOST PLANT:** A plant's genetic susceptibility and general vigor.
- **ENVIRONMENT:** Weather conditions, soil conditions, density of the planting and location.

What Is Needed To Cause Plant Disease?



mcKew 1960

Diseases are the result of three things in combination:

1. Pathogen
2. Host
3. Environment favorable to disease

This is summarized in the Disease Triangle.
Each of the three components needs to be understood.

Disease Development

Relates to the disease triangle

Disease cycle:

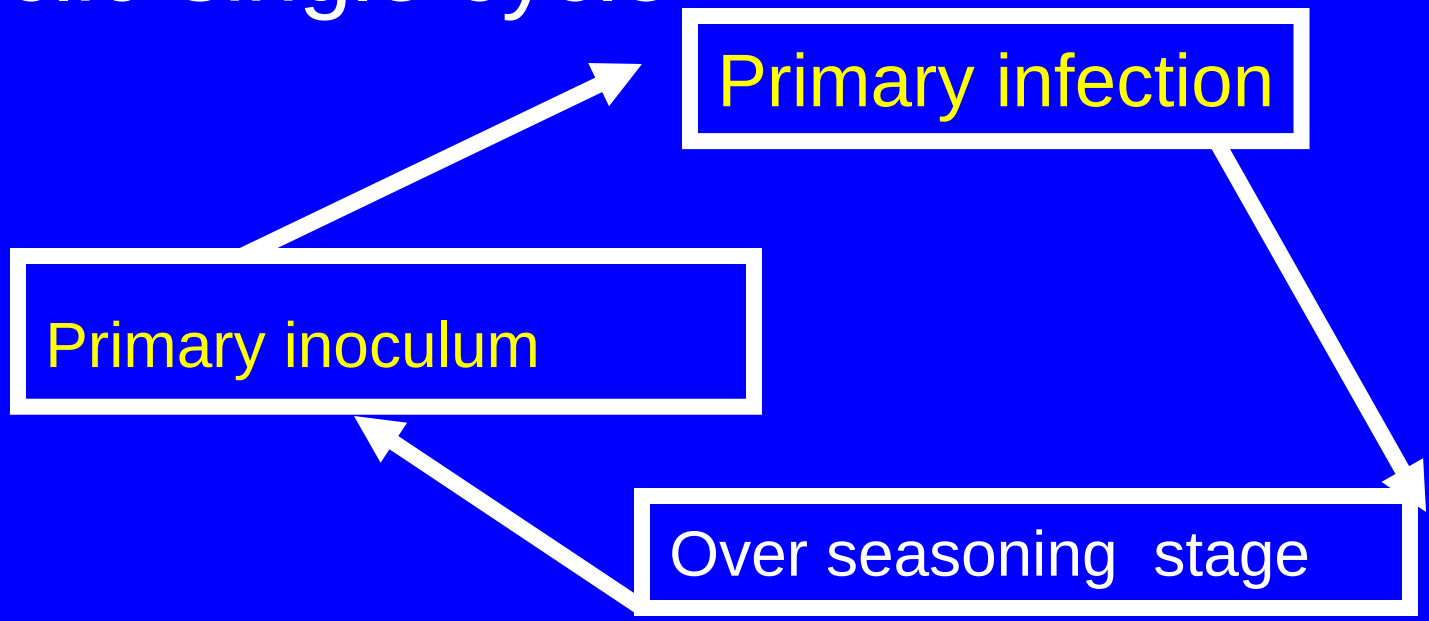
- Involves the changes in the plant and pathogen over time (within a growing season) and the pathogen's life cycle from one season to the next.
- Refers primarily to the appearance, development, and perpetuation of the disease.

Disease Cycles

Monocyclic vs. Polycyclic

Monocyclic-single cycle

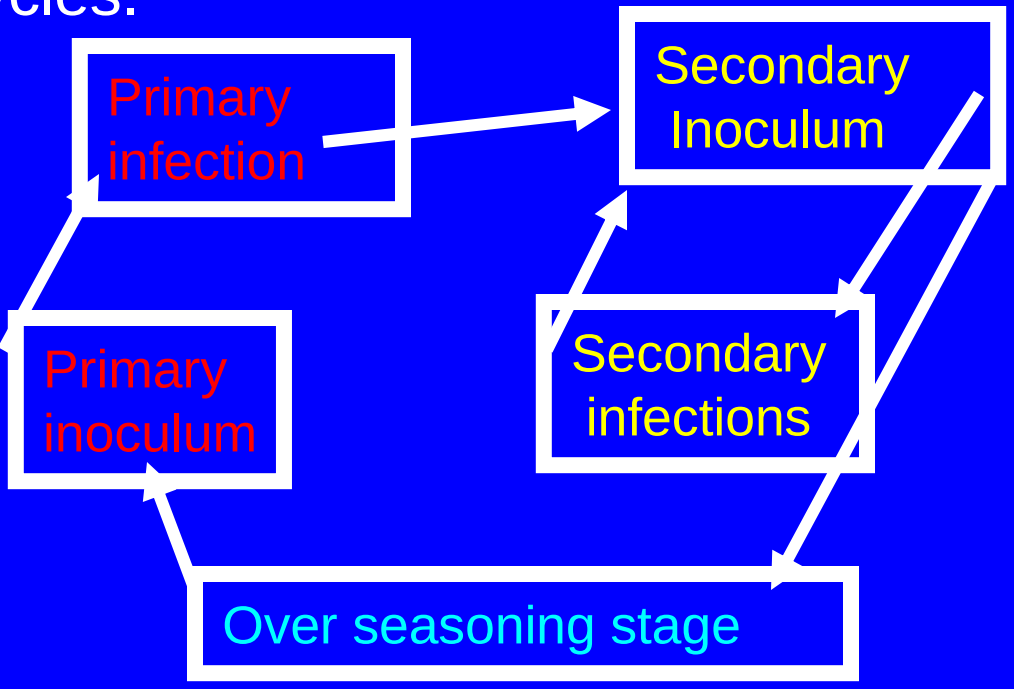
Common smut (Ustilago maydis) on sween corn.
Courtesy Harold Kaufman, TAEX, 1996.



Ex- smut fungus- produces spores at the end of the growing season- these serve as the primary and only inoculum for new infections the following growing season.

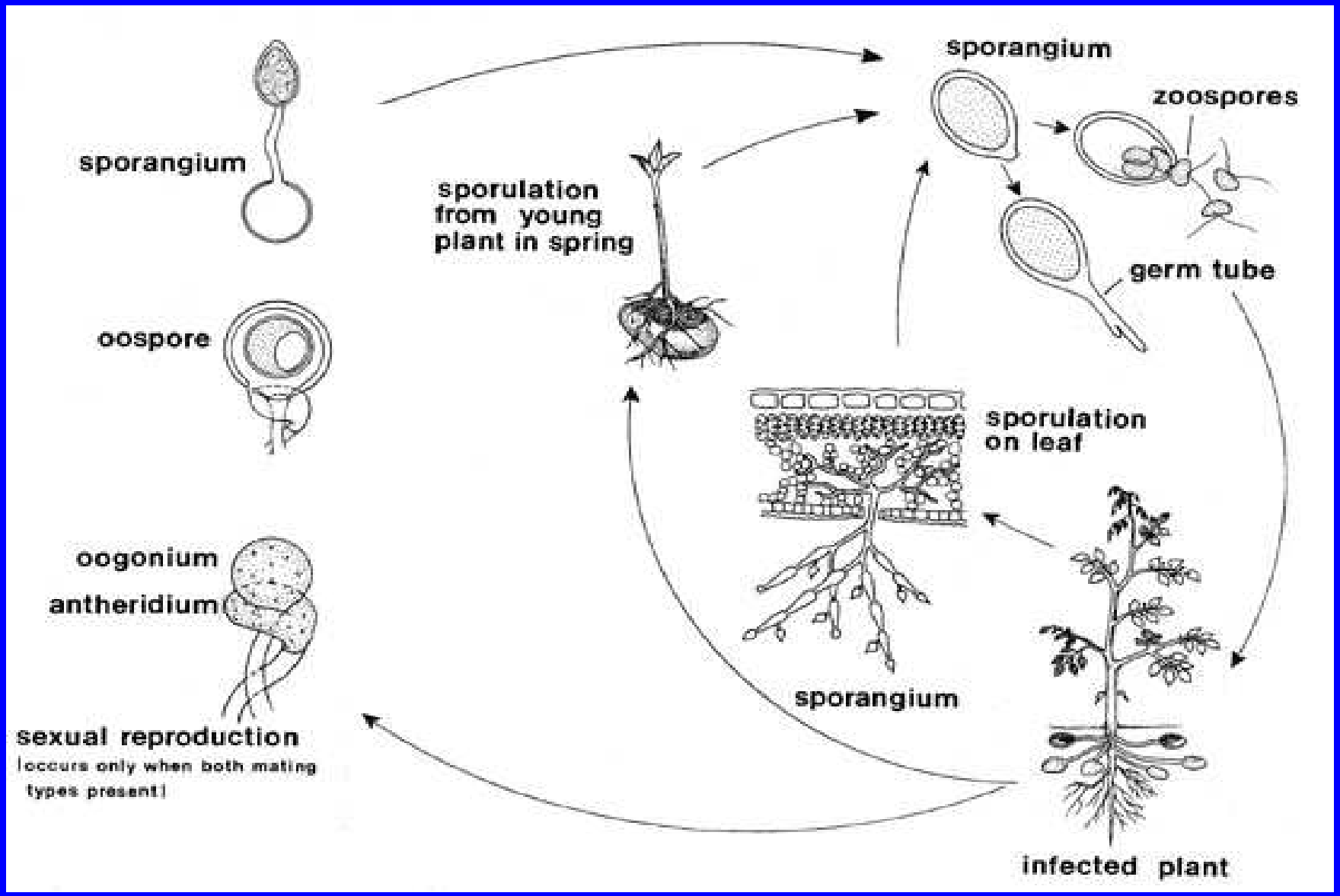
Disease Cycles

Polycyclic (multiple cycles)- Pathogen goes through more than one generation per growing season.
2-30 cycles.



Polycyclic pathogens are disseminated primarily by air or air borne vectors/ insects, or water.
Responsible for the most explosive epidemics- late blight of potato, grain rust, insect-born viruses, powdery mildews, spots and blights.

Late Blight Disease Cycle -- *Phytophthora infestans*



Stages of Disease Development

1. Inoculation
2. Incubation
3. Penetration
4. Establishment of infection
5. Colonization (invasion)
6. Growth and reproduction of the pathogen
7. Dissemination of the pathogen
8. Survival of the pathogen in absence of the host (over-wintering or over-summering of the pathogen)

Causes of Disease

BIOTIC…..	Or infectious/living
ABIOTIC…..	Or non- infectious non-living/cultural

Biotic Disease

- Diseases caused by living entities; persistent.
- They reproduce, spread from plant to plant and grow!!!
- Almost always use the plant for food.
- Biotic = pathogenic

Spread of Pathogens

- Wind/rain
- Irrigation
- Insects
- Planting machines
- Nematodes
- Contaminated plants and seed
- Clothes/shoes debris
- Animals
- Pruning tools

Pathogen Host Range

- Pathogens differ with respect to
  - kinds of plants they can attack
  - the tissues and organs they can attack

- Some can attack only one or a few species of a particular genus; narrow host range.
- Others can affect an entire genus, more extended host range.
- Still others are pathogens that affect multiple plant families- broad host range.

Host Parts Affected

- Roots
- Stem
- Foliage
- Fruits and fleshy parts
- Vascular tissues
- Pathogens attack in some cases only seedlings and have less of an effect on mature seedlings.

How Pathogens Attack!!

MECHANICAL

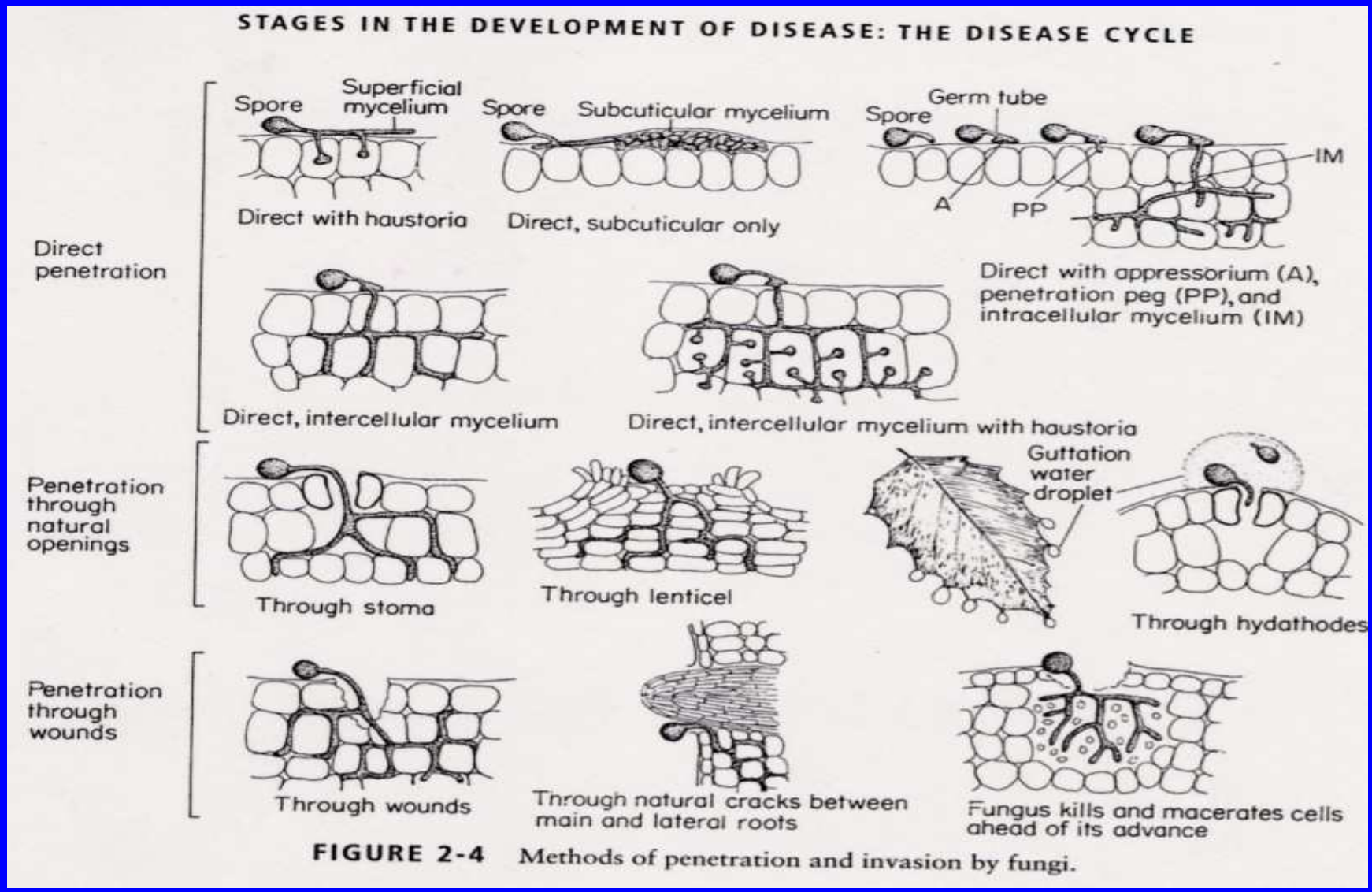
CHEMICAL…… Most pathogens have and use them.

A. Enzymes

B. Toxins

C. Growth regulators

Routes of Entry For Plant Pathogens



Abiotic Disease = Environmental

- Non-infectious diseases caused by non-living entities
- They do not grow, reproduce, or spread from plant to plant

Abiotic Disease

- Caused by extremes of light, moisture, temperature and air and water pollution.
- Caused by pesticide toxicity, and by disruption of a plant's root environment by compaction, excavation and other human activities

Review

- Plant Pathology- definition
- Plant Disease- definition
- Disease indicators
- Case study of *Phytophthora infestans*
- Disease triangle
- Disease cycles
- Abiotic vs. Biotic Disease

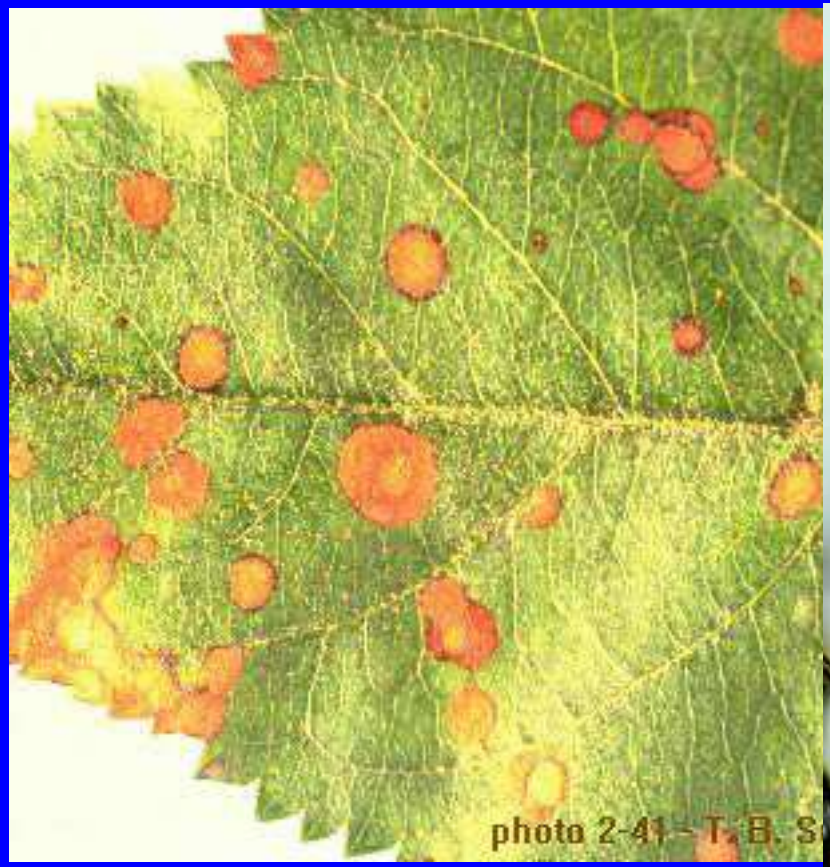
- Next- Symptoms vs. Signs

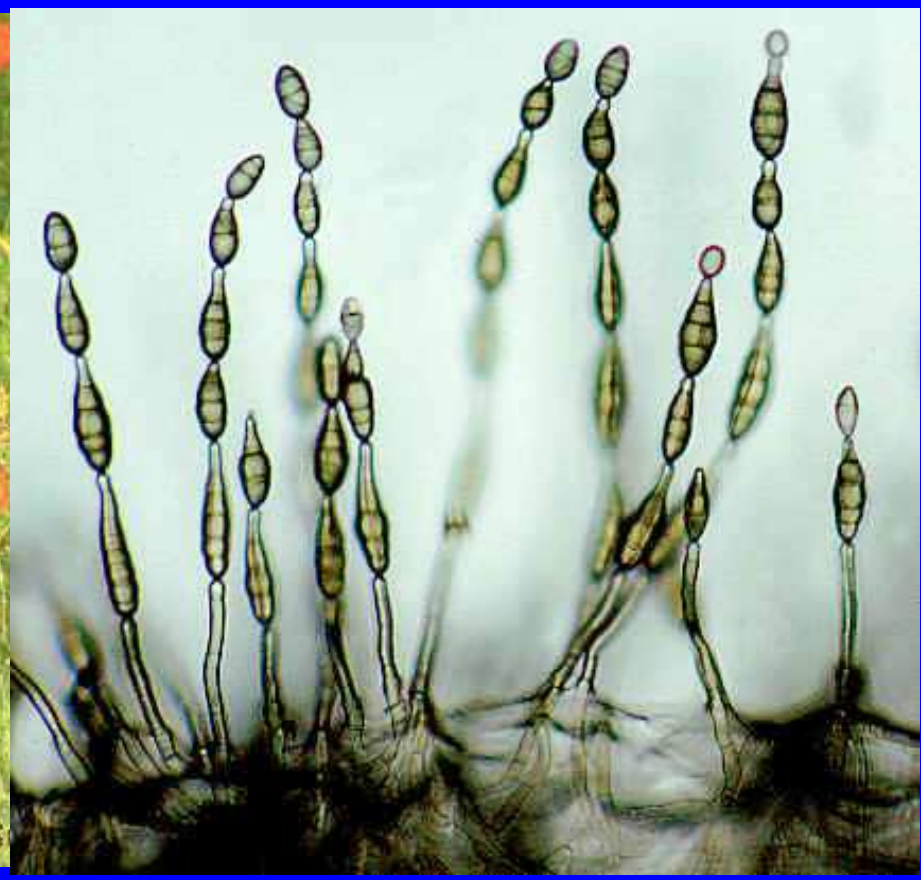
What Is a Symptom?

A symptom is the reaction or alteration of a plant as a result of the disease

- Spots
- Wilts
- Cankers
- Galls
- Root rots etc.

Alternaria - Many Leaf Spots and Blights





Alternaria mali

Dutch Elm Disease
Caused by *Ophiostoma Ulmi*

Elm (*Ulmus* species)

DISEASED

HEALTHY

What Is a Sign?

A sign is the pathogen or its parts seen on the host plant

- Fruiting structures
- Mushrooms
- Mycelium
- Bacterial ooze
- Sclerotia

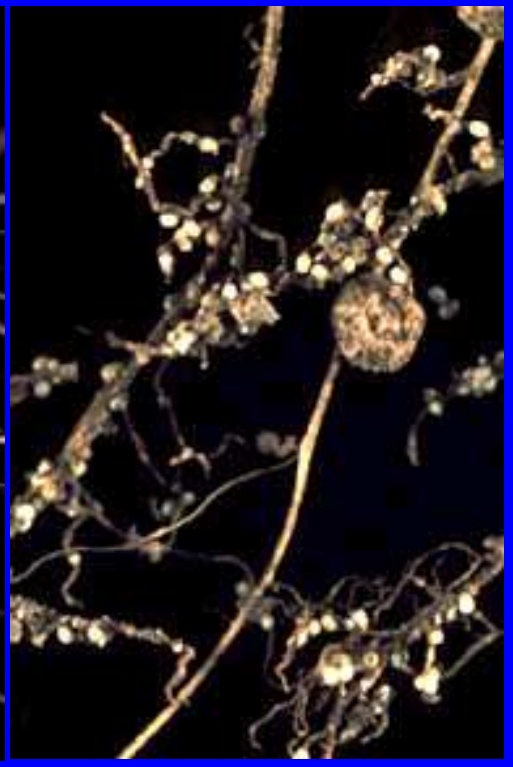
Sign

Dodder (*Cuscuta* spp) is a parasitic vascular plant lacking chlorophyll. It is easily recognized by its orange, leafless stems (orange spaghetti), and tiny, white flowers massed in a cluster (right). Dodder obtains its nutrients from the host plant via haustoria, which penetrate the stem.

Powdery growth and cleistothecia on leaf surface

Ruptured cleistothecium showing several asci containing ascospores

Sign



Soybean Cyst Nematode

Heterodera glycines

Living (Biotic) Things That Cause Plant Disease

- Fungi
- Bacteria
- Viruses
- Nematodes
- Parasitic Plants

Common Symptoms

- **LEAF SPOTS:**
  Discolored, distinct spots on leaves
- **LEAF BLOTCHES**
  Blotchy dead or discolored areas on leaves
- **BLIGHTS:**
  Rapid death of plant parts or entire plant
- **GALLS:**
  Tumorous tissue on plant
- **CANKERS:**
  Sunken dead areas on surface of stem
- **ROOT ROTS:**
  Softened, blackened or brown tissue in the roots

Common Symptoms
(Continued)

- **LESIONS:**
  Small local area of malformed tissue
- **NECROTIC LESIONS:**
  Dying and dead tissue; blackened, holes
- **CHLOROSIS:**
  Yellowing of tissue
- **WILTING/FLAGGING:**
  Foliage on all or part of plant wilted, dying
- **VASCULAR STREAKING:**
  Discolored streaks in xylem and phloem

Symptoms of Disease

- Changes in the plant produced by disease
- Discolored, malformed or dying regions on plants

LEAF SPOTS

- Can be large or small areas of damaged leaf tissue.
- Spots can be yellow at first, then turn tan, brown or black.
- Their centers may drop out, leaving a shot hole appearance.

From U. of Missouri Soil Plant Lab.

Leaf Spot Examples

BLIGHTS

- Usually the rapid killing of leaves and branches
- Caused by fungi or bacteria
- Common ones:
  - Fire blight
  - Late blight on potatoes (*Phytophthora*)
  - Bacterial blight on geraniums
  - Botrytis blight

Fire blight (*Erwinia amylovora*)

Lophodermium -- Needle Blight

Cryphonectria parasitica -- Chestnut Blight

Chestnut tree canker showing bursting of the bark on a young chestnut trunk

LEAF BLOTCHES

- Refers to dead areas on leaves, may be along leaf margins or between veins
- Spots may have concentric line patterns or dark pimple-like fruiting structures in them

Gnomonia veneta
Sycamore anthracnose

Disease may kill the tips of young twigs (blight) before leaves emerge and the buds open. When the leaves are present, they exhibit typical blotch symptoms and early defoliation is common.

Fungus spreads into the twigs and produces cankers on branches. Fungus overwinters as mycelium and as immature perithecia in twig cankers and fallen leaves. The disease is favored by cool rainy weather.

Gnomonia
Anthracnose of Forest and Shade trees

Oak anthracnose

Walnut anthracnose

Maple anthracnose

GALLS

- Can be caused by many different things including insect feeding, tissue from wound healing, fungi, and bacteria.
- Some plants cannot be cured of galls.
- Common bacterial gall caused by *Agrobacterium tumefaciens.*

GALL= The uncontrolled growth of plant tissue

Disease: Club root of Crucifers

Club root occurs worldwide and once fields have become infested disease management is difficult.

Pathogen produces zoospores, plasmodia, and resting spores (cysts).

Plant Galls

- Excessive tissue growth
- 1. *Agrobacterium tumefaciens*

Black Knot of Plum & Cherry

Galls caused by the fungus *Dibotryon morbosum*.

CANKERS

- Localized, sunken, dead areas on bark and underlying wood on twigs, branches and trunks.
- Caused by either living organisms or by abiotic conditions.
- Pathogens gain entry through natural or man–made wounds and cause disease when the plant is under stress.

Cankers

3 TYPES

- Annual: caused by fungi - not a serious problem unless tree is stressed
- (ex. Fusarium canker on maple)
- Perennial cankers: weaken trees and persist from year to year (ex. Nectria canker)
- Diffuse canker: elongated, rapidly spreading fungus. Often girdles branches or whole trees (ex. Chestnut blight)

Cankers

- Pruning can be done if canker is small. Prune out below canker.
- Do not prune late in dormant season or in the fall. Cankers can release spores during that time and infect the pruning wound.
- Promote tree vigor.

Cankers

Fire Blight of Apple
Erwinia amylovora

Nectria canker on white birch

Chestnut blight canker

ROOT ROTS

- Can be caused by several different genera of fungi.
- *Pythium, Rhizoctonia, Fusarium* and *Phytophthora* are examples.
- Common in field soils and dead roots of previous crops.
- All plants can be susceptible to rots at some stage of development.

Root Rots

SYMPTOMS

- bases of cuttings are brown or black and become soft.
- Plants are stunted.
- Root tips are brown and dead.
- Plants wilt at mid-day and recover at night.
- Plants yellow and die.
- Brown tissue on the outer portion of the root peels off easily, leaving a bare strand of vascular tissue exposed.

Red Stele Disease of Strawberry

Root Rot

- Difficult to control once rot has begun.
- Can use pasteurized soil mixes in greenhouse or pots.
- Disinfect all work surfaces, tools, and equipment.
- Apply fungicide to reduce spread of rot organism if necessary.

Disease: PHYTOPHYTHORA ROOT ROT
Host: Rhododendron

LESIONS

- Small localized area of malformed tissue.
- Dead and dying tissue, followed by blackened areas; can have holes.
- Can often be pruned out.

Lesion

localized area of diseased tissue

Disease: **Rhizoctonia Root and Stem Rot**

This fungus is soil-borne and causes damping-off of many crops. Cultural practices can reduce losses, but eradicating the pathogen from the soil is more effective. Fungicides CAN BE SOMEWHAT EFFECTIVE as soil treatments.

Lesion

localized area of diseased tissue

Disease: **Dollar Spot on Turfgrass**

Individual lesions have straw-colored centers with reddish-brown borders. The disease is first seen as small spots of blighted grass, but these spots may develop into circular, straw-colored patches 2-3 inches (5-7.5 cm) in diameter. Control is primarily with fungicides.

VASCULAR WILT

- Rate affecting the plant varies, some wilts spread quickly, others more slowly.
- Symptoms- yellowing, wilting, defoliation, discoloration of wood
- Common vascular diseases:
  - Dutch elm disease
  - Fusarium wilt of tomatoes
  - Verticillium wilt of trees

Vascular Wilting/Flagging

- Pathogens attack food and water conducting tissue of the plant xylem and phloem.
- Spread by insects or pass from plant to plant by root grafts.
- Pathogens can live in soil, plant debris, plant tissue.

Vascular Wilt

- Streaking -- partial blockage of vascular system is an early indication of wilt.
- Once wilts have occurred, may be too late for plant to be saved.

Wilts

Wilt: A flaccid appearance of leaves and shoots resulting from a temporary or permanent loss of turgor due to excess transpiration of the leaves and shoots.

Subclass: Deuteromycetes

Verticillium -- Vascular Wilts

RUSTS

- This term refers to diseases caused by several different genera of fungi that have dry, powdery, reddish-orange spores.
- All are obligate parasites.
- Some require two different species of host plants that must be present to complete its life cycle.
- Others require only one type of host.

Rusts

Common rusts found in the United States

- Cedar-apple rust
- Cedar-quince rust
- Cedar-hawthorn rust
- Corn rust
- Wheat rust
- White pine blister rust
- Hollyhock rust
- Bean rust
- Turfgrass rust

Gymnosporangium juniperi-virginianae
Cedar-Apple Rust

Primary host: CEDAR (Juniperus spp.) Alternate host: APPLE

Telial gall of
cedar-apple rust
on cedar,
with spore horns
withered after spore
germination

Photograph courtesy C. W. Mims

Rust on Hollyhocks and Roses

Review

- What is a symptom? Reaction or alteration of a plant as a result of the disease. Examples- spots, wilts, cankers, galls etc.
- What is a sign? Actual pathogen- mycelium, fruiting structures, bacterial ooze, etc.

Living (Biotic) Things That Cause Plant Disease

- Fungi
- Bacteria
- Viruses
- Nematodes
- Parasitic Plants

Parasite vs. Saprophyte

PARASITE:	Obtains nutrients from living tissue of other organisms; eventually it may destroy the plant. Examples: rusts, powdery and downy mildews
SAPROPHYTE:	Lives on dead organic matter

Most pathogens have both parasitic and saprophytic stages in their lifecycle.

Introduction to Plant Pathogenic Fungi

- Classification of Fungi – Fungal Taxonomy
- 1. Myxomycetes -slime molds-plasmodia
- 2. Oomycetes –Zoospores with 2 flagella

  True Fungi
- 3. Chytridiomycetes –unicellular or short chains of cells.
- 4. Zygomycetes -aseptate hyphae
- 5. Ascomycetes spores in asci (sacs)
- 6. Basidiomycetes- spores on clubs
- 7. Fungi imperfecti- no sexual stage

FUNGI

- 100,000 species, 700 species in soil
- Very diverse group
- Yeasts - single-celled
- Molds/mushrooms grow as strands called hyphae
- Tolerate wide pH range
- Mushrooms are visible fruiting bodies

Source: Ann Lewandowski, NRCS

FUNGI

- Organisms with thread-like structures.
- They do not contain chlorophyll.
- They cannot produce their own food.
- Enter plants through natural openings, wounds or penetrate directly through intact plant tissue.

Fungi

- Fungi produce spores that are capable of surviving adverse conditions and dispersing themselves.
- The way spores are formed and their size, color and structure are all used to identify fungi.

Spore Types

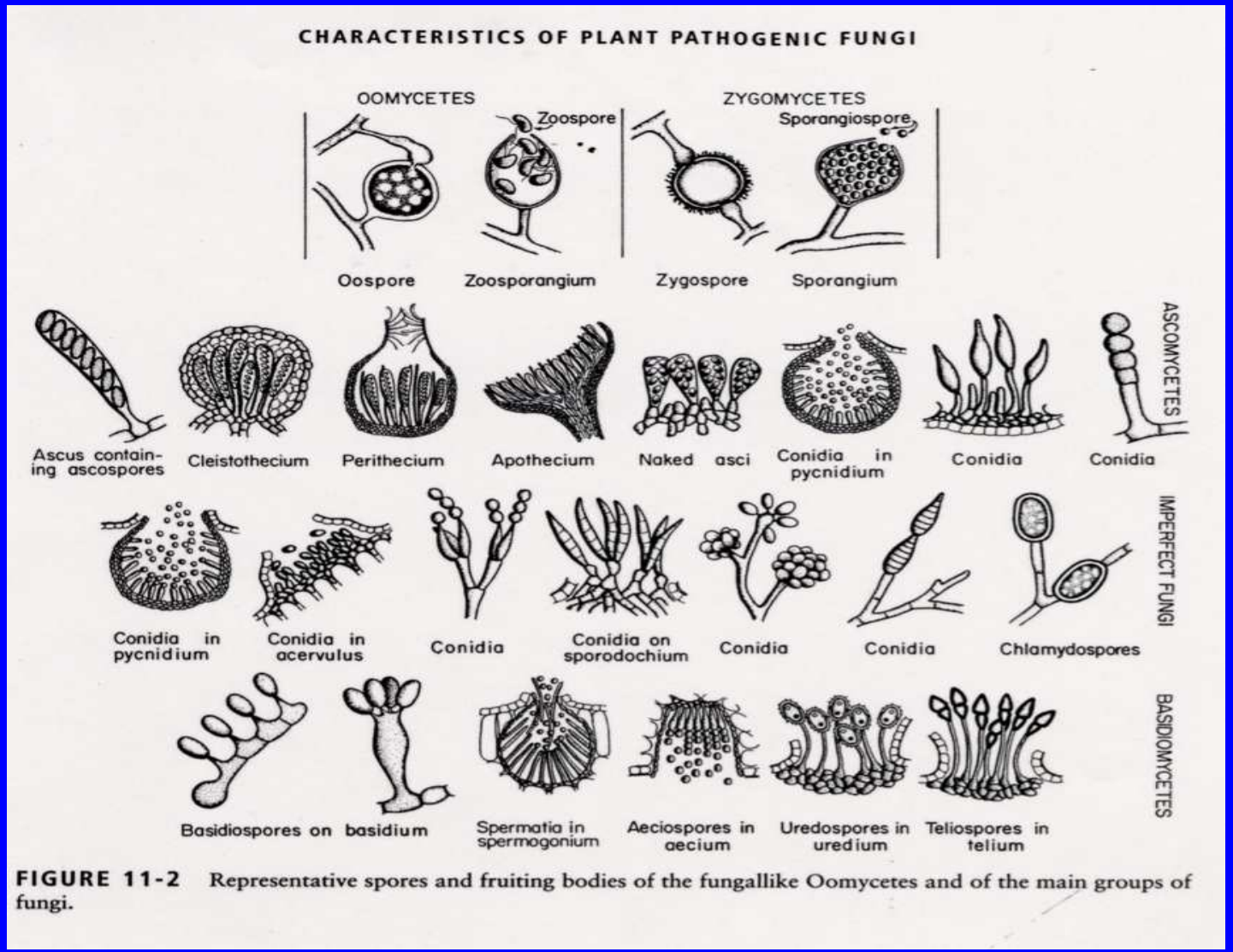
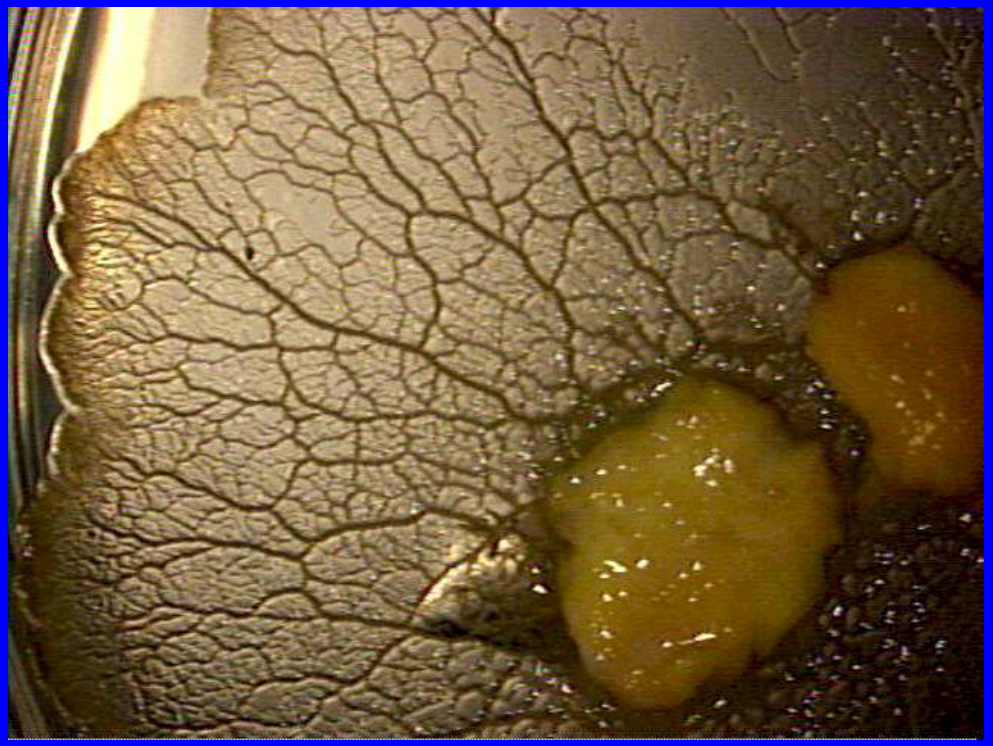


FIGURE 11-2 Representative spores and fruiting bodies of the fungallike Oomycetes and of the main groups of fungi.

Myxomycetes- Slime molds

- Kingdom-Protozoa
- Slime molds- Have no cell wall
- No mycelium; have plasmodium
- Zoospores (motile)
- Found on plants or organic matter that are low on the ground, common in warm weather after heavy rains.

Slime Molds



Dog vomit fungus

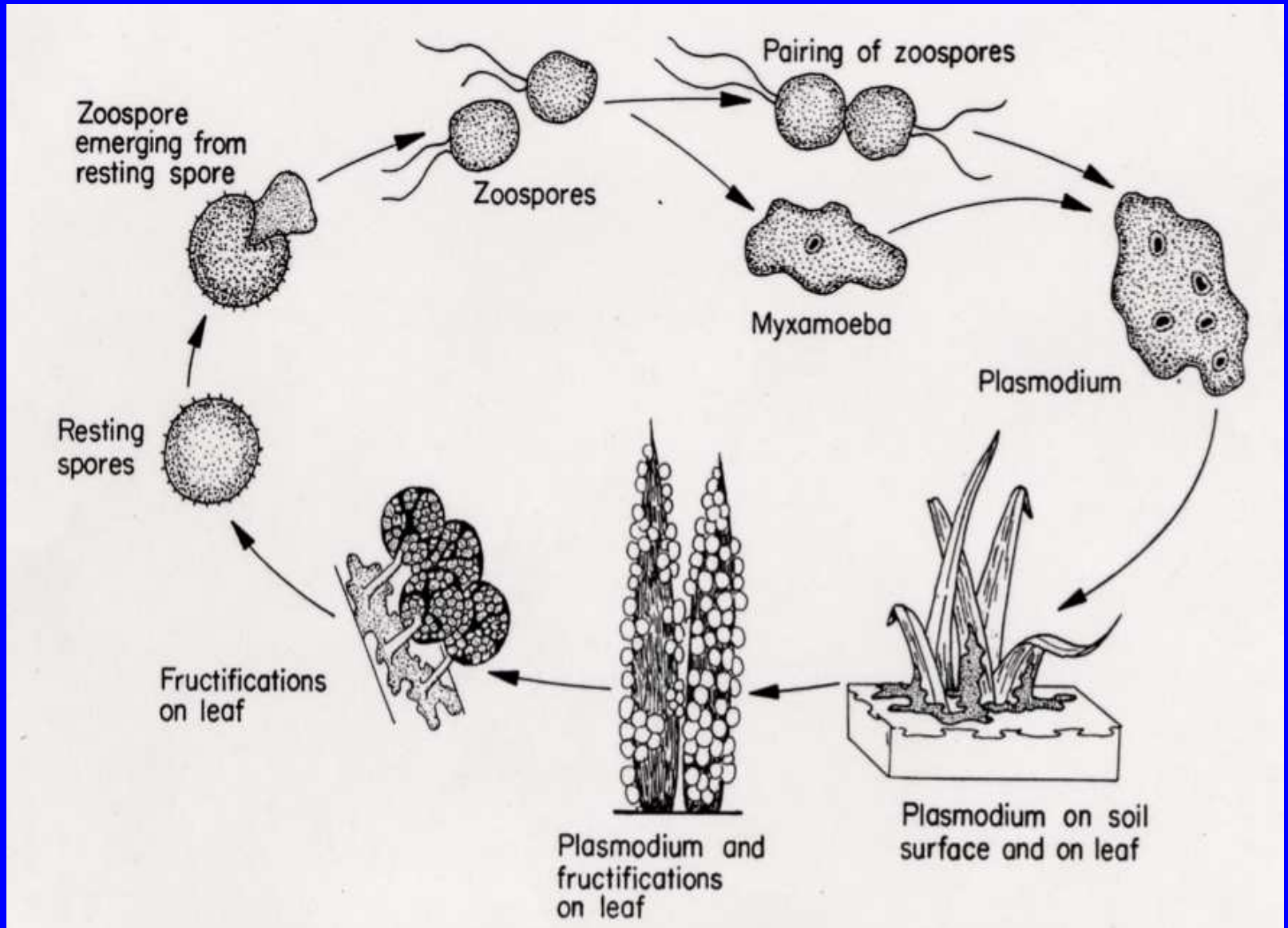


FIGURE 11-9 Life cycle of slime molds.

Slime Mold Spores

Spore dispersal

Slime Mold on Turfgrass: More of a Curiosity than a Problem

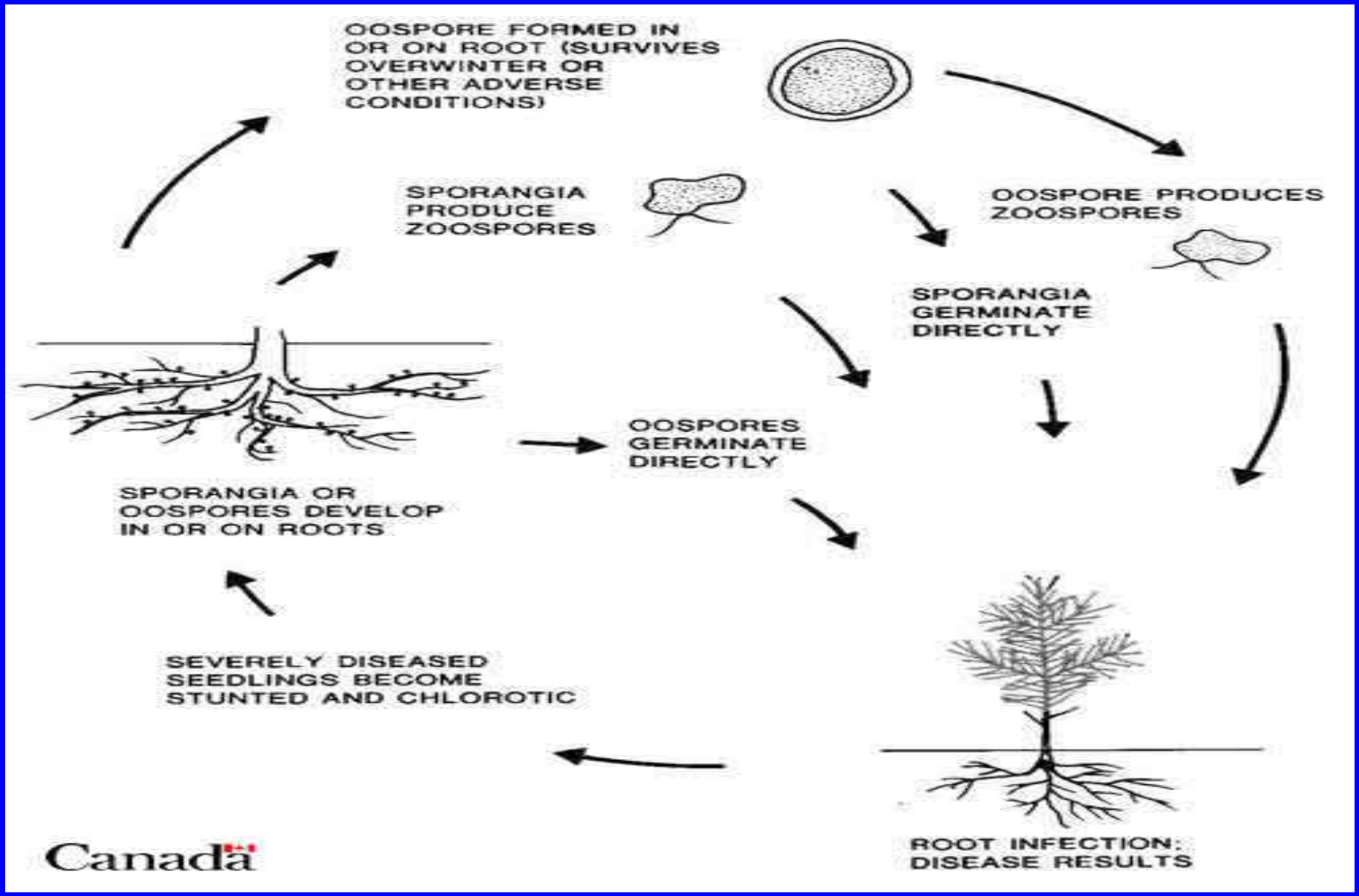
Appears after a warm summer rain.
First, a slimy growth; then growth dries into a powdery mass of spore-bearing structures that coat grass blades.
No need for control.

Oomycetes: Pseudo-fungi

- Kingdom- Chromista
  Phylum- Oomycota
  Class- Oomycetes-Have mycelia, no cross walls.
  Produce oospores as sexual resting spores and zoospores as asexual spores.

Pythium- Seed rot, seeding damping off, root rot of all types of plants, soft rot on fruits.
Phytophthora-Late blight of potato
Peronospora- Downy mildews

CLASS- Oomycetes



Pythium Blight of Turfgrass

Sometimes the infected area may give off a fishy odor.

DETECT by removing a plug of diseased turf and placing it into a plastic bag. Seal the bag, and put it in a warm spot. Within a few hours both the fishy smell and characteristic mycelium should be noticeable. By mid-morning the infected leaves dry, shrivel, and turn reddish-brown.

The disease is most easily diagnosed when the infected area is observed in the early morning when the characteristic mycelium and GREASY APPEARANCE of the blighted turf are present. These signs and symptoms can be extended later into the morning by covering one of the spots so that it will not dry out.

If the weather remains hot and humid, the spots coalesce and often kill large areas of turf.

Pythium Blight on Turfgrass

09. Pythium blight of an *Agrostis palustris* golf green. Courtesy P. H. Dernoeden)

Diseased area begins with small reddish-brown spots that can increase in size under favorable conditions.

Pythium Blight of Turfgrass

In the morning dew, infected grass leaves appear water-soaked, slimy to the touch, and dark green.

When the grass is wet, a white fungal mycelium, resembling a fluffy cotton ball can be present on the grass blades. Infected plants collapse and cause the grass in the blighted spots to appear matted.

Pythium Blight on turfgrass

Grease spot phase

Pythium Life Cycle

Pathogen survives OVERWINTER as oospores.

It can be moved from one area to another by soil movement, by transporting diseased plants or plant parts, and by equipment, shoes, or surface water.

Spread from these areas can be rapid in WET or HUMID HOT WEATHER.

HIGH NITROGEN FERTILITY FAVORS THIS DISEASE.

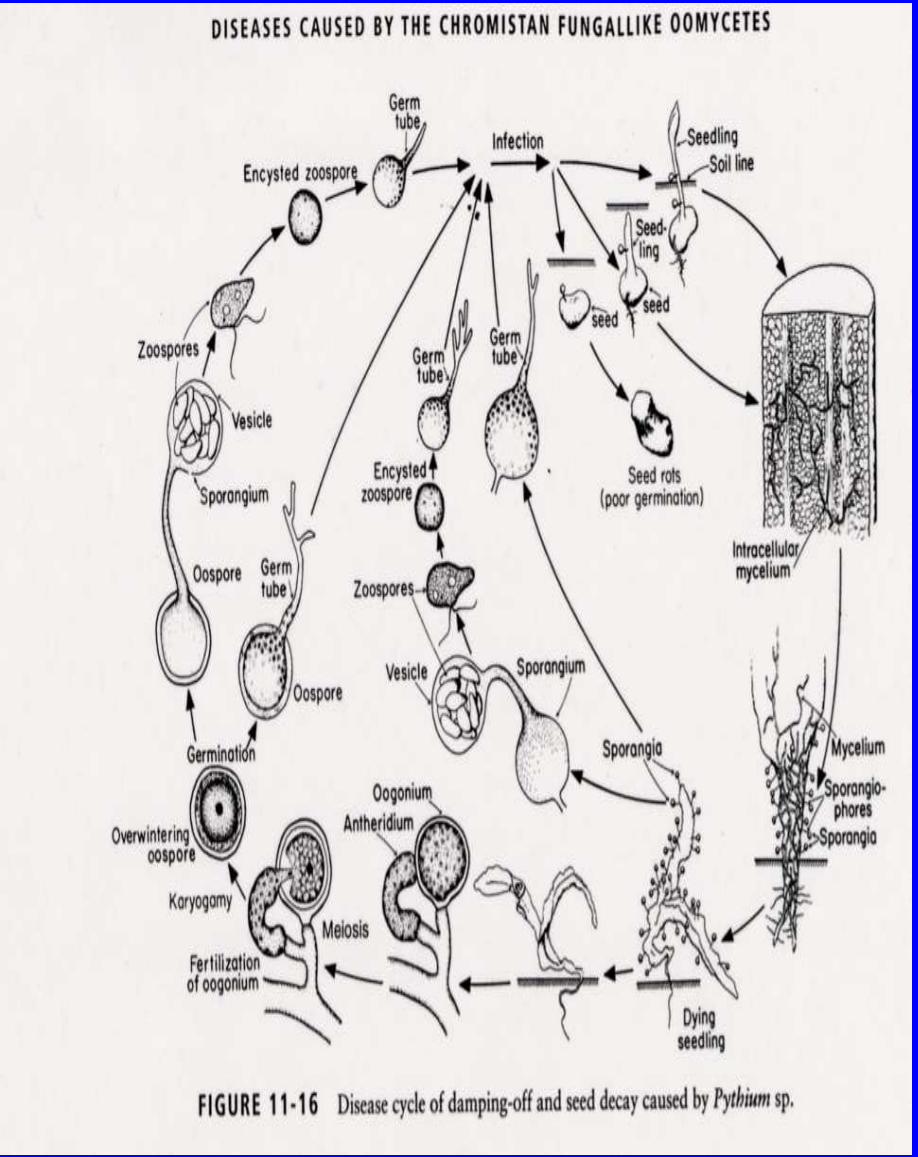


FIGURE 11-16 Disease cycle of damping-off and seed decay caused by *Pythium* sp.

Cultural Practices for Pythium Control on Turf

- Provide adequate soil drainage.
- Fill depressions where water puddles.
- Thin landscape plantings to allow for good air movement across the turf.
- Avoid mowing and traffic on wet turf.
- Use a balanced fertilizer that won't stimulate lush growth in summer.
- Avoid overwatering and late afternoon-early evening watering during periods of hot, humid weather.
- Reduce thatch by regular aeration or power raking.

Pythium Root Rot on Oats

Pythium rot in the greenhouse on potted roses.

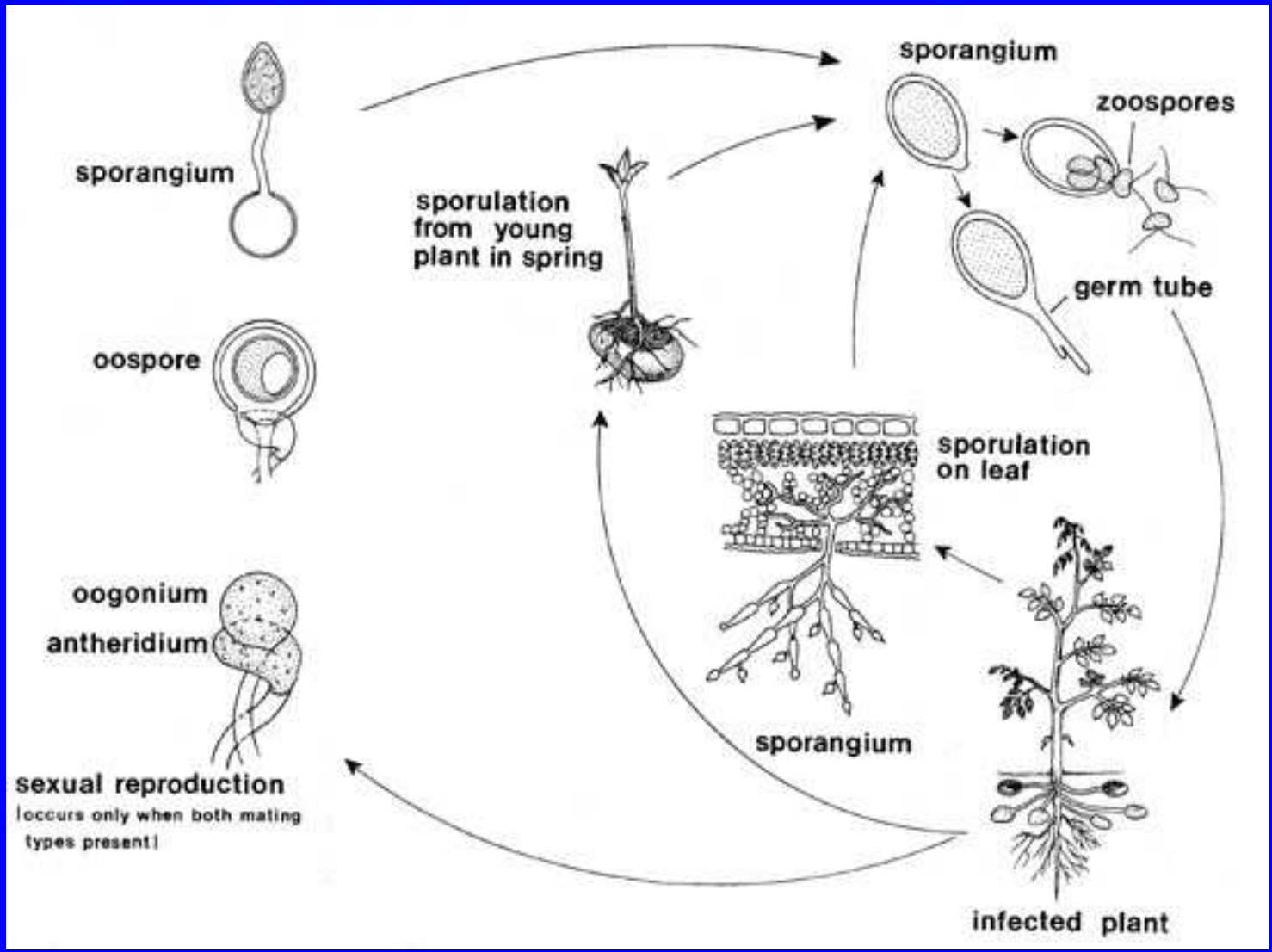
Phytophthora infestans -- Late Blight Organism

SYMPTOMS AND SIGNS: early symptoms -- water-soaked or with chlorotic borders that expand rapidly

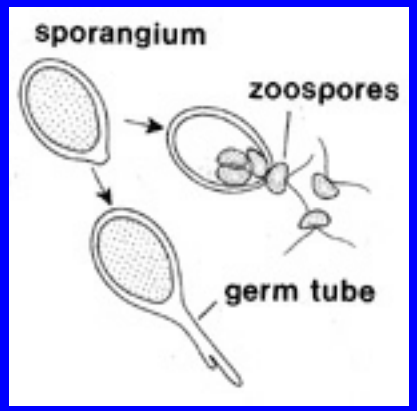
Phytophthora infestans
Late Blight Organism

Late Blight of Tomato

Late Blight Disease Cycle -- *Phytophthora infestans*

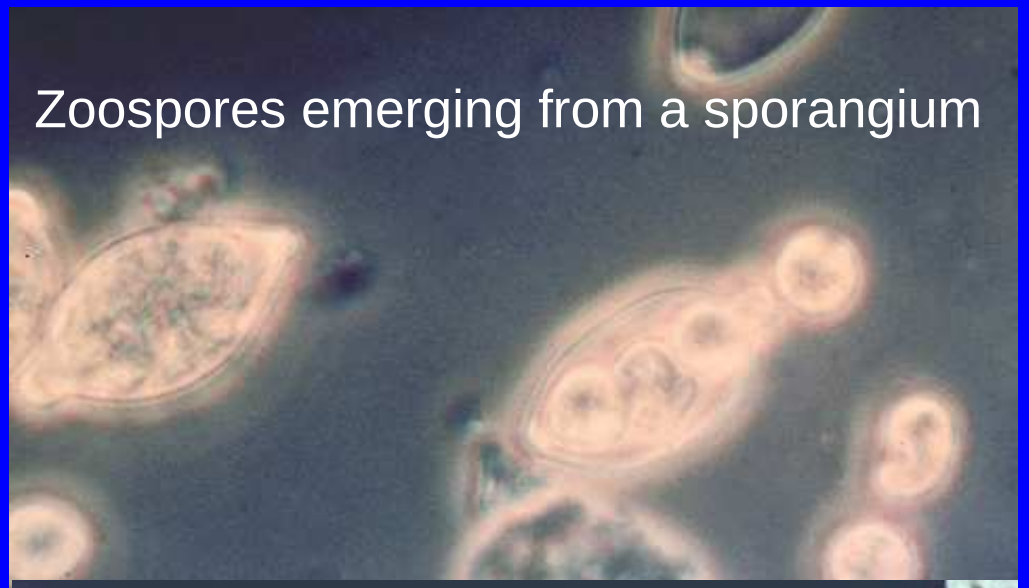


Late Blight Disease Cycle -- *Phytophthora infestans*



In the presence of water and at cooler temperatures, sporangia germinate directly and produce zoospores.

Below 18°C (65℉), sporangia produce 6 to 8 zoospores



Late Blight Management

Preplanting management options:

- Cultivars: no potato cultivar is immune to all strains of *P. infestans.*
- Some are more resistant than others.

CONTROL

SITE SELECTION Good drainage and good air movement will help reduce moisture levels in the canopy. Fields bordered by trees and dense vegetation should be avoided.

CROP ROTATION Rotations of 2 to 3 years to non-host crops.

ELIMINATION OF OVERWINTERING SPORES

Tubers infected in the previous season are the most important source of initial inoculum.

MANAGEMENT

Hilling: Soil can be made deeper around the base of the plants after emergence of the young potato plants. Hilling helps in early weed control and minimizes tuber infections from sporangia that wash off the leaves of infected plants into the soil.

FUNGICIDES

When conditions are favorable for disease development or the pathogen is known to be present.

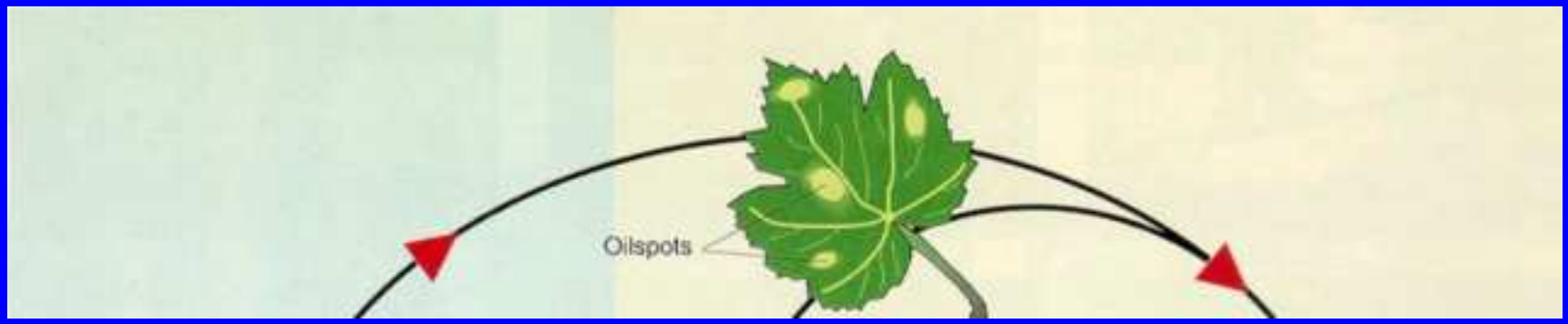
Downy Mildews-Peronosporaceae

Grayish downy mildew fungal growth on the underside of a spinach leaf.

Downy Mildew on Grape

Plasmopora viticola

Fungal tissue of downy mildew.



Upper side of the infected leaf

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