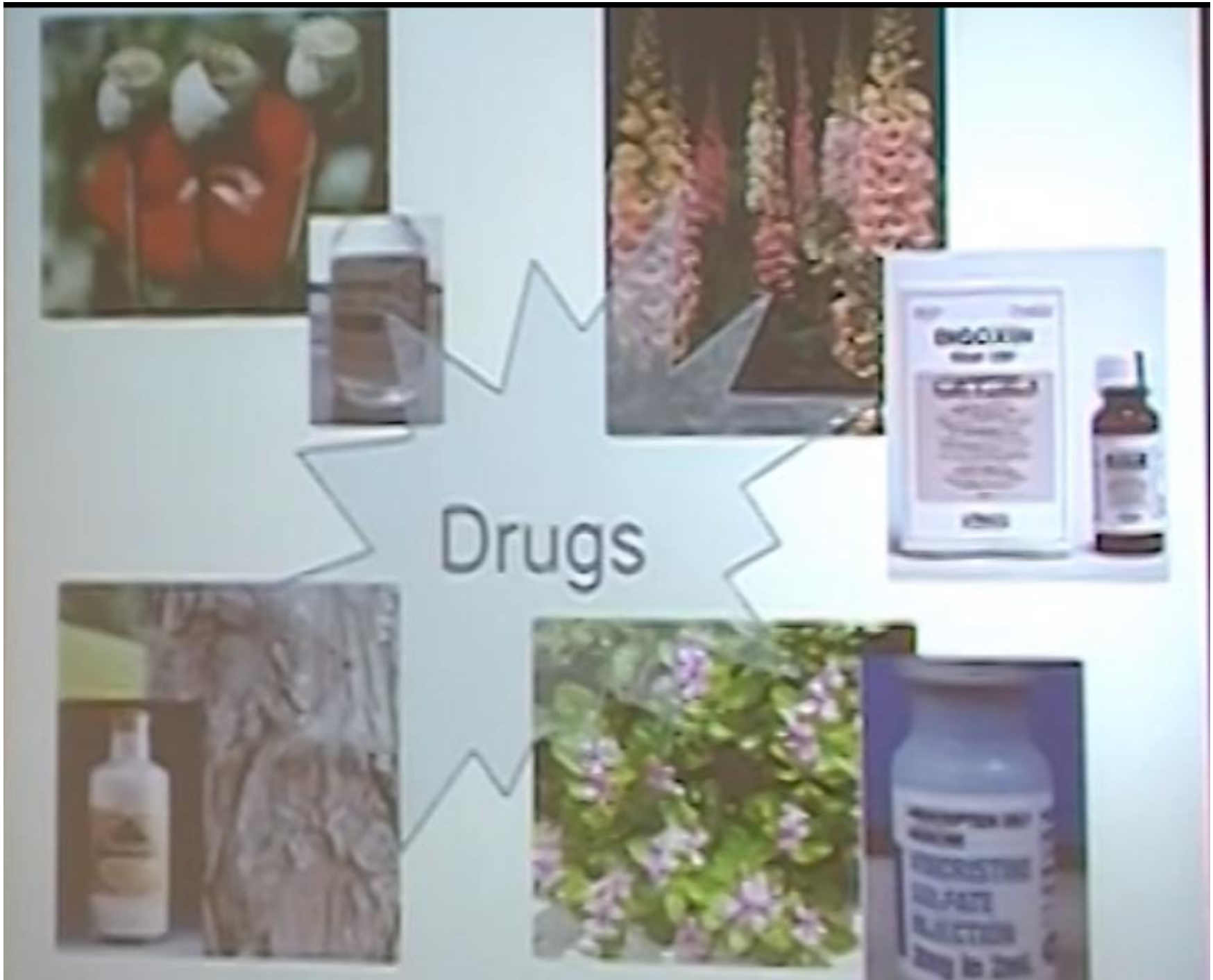
Phytopathogenic Microorganisms. Methods of the Microbiological Control

1. Microflora of plants
2. Invasiveness of plant pathogens
3. Factors of protection of plants against infections
4. Control of diseases of plants
5. Method of the microbiological control of medicinal raw materials and medicines.


Drugs

Primary Causal Agents

- **Biotic (infectious)**: living organisms (pathogens) that have the ability to infect plants and cause disease
- **Abiotic (non-infectious)**: disorders induced by non-living causes such as environmental conditions (majority of problems on plants tend to fall in this group)

Types of Plant Pathogens

Biotic

- Fungi
- Bacteria
- Nematodes
- Viruses

- Parasitic plants

Abiotic

- Environmental factors. Extremes in:
  - Temperature
  - Moisture
  - Light
  - Nutrients (mineral elements)
  - pH
  - salinity
- Chemicals:
  - Pest control products, herbicides

Microflora of plants

- Epiphytic microorganisms – normal, non-pathogenic
- Phytopathogenic microorganisms – cause disease of plants including medicinal herbs


Fungi


Bacteria

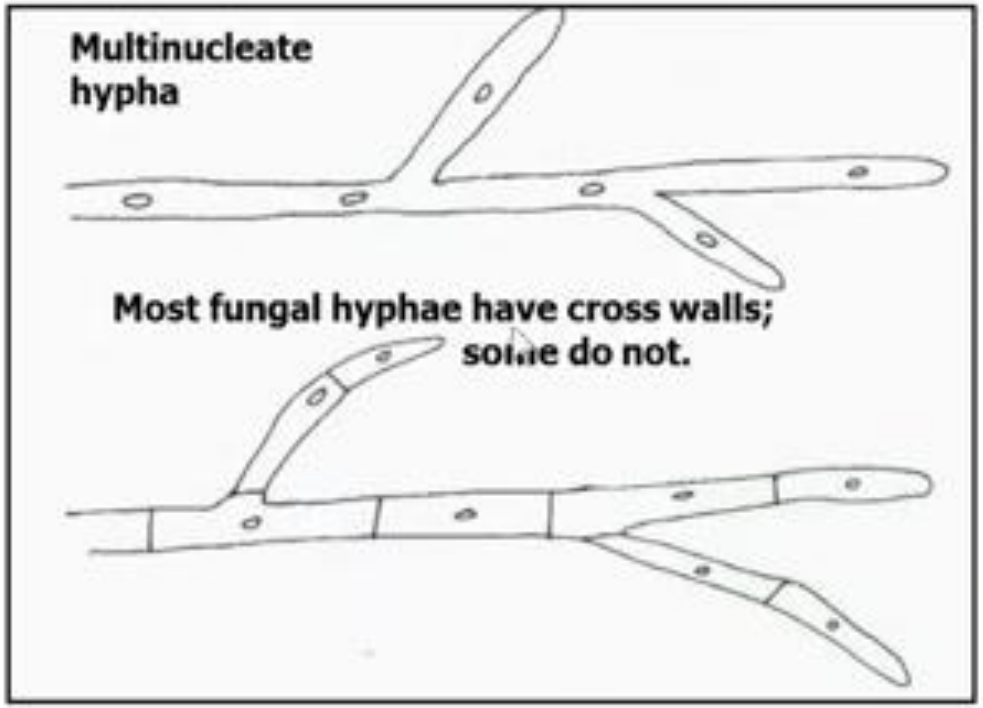

Virus


Insect

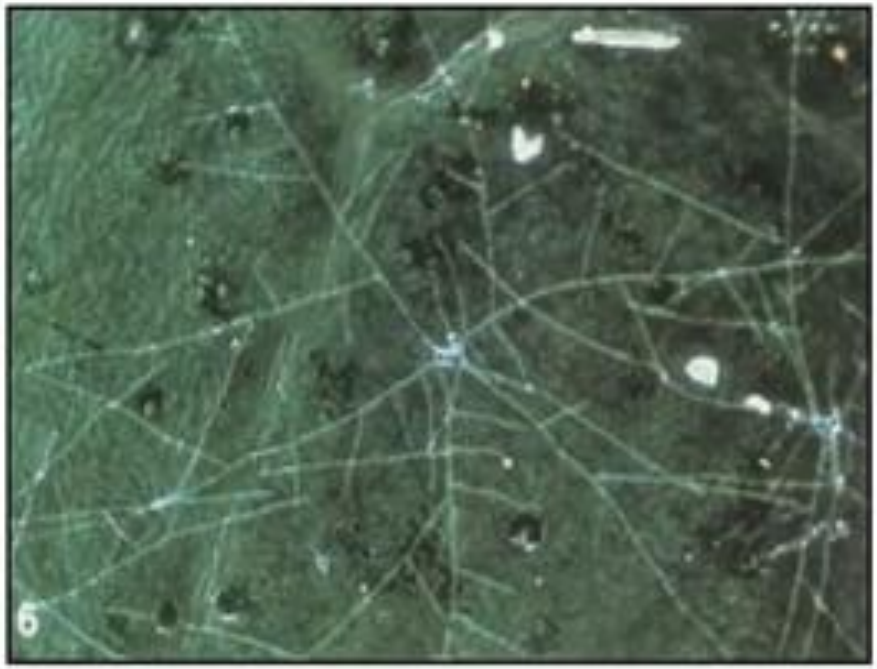
Phytopathogenic microorganisms

The microorganisms that cause disease of plants including medicinal herbs are cold the phytopathogenic microorganism. This microorganism influence productivity of plants. Sick medicinal herbs cannot be use for getting a medicinal raw material of them, and of course for making the medicines.

Fungi



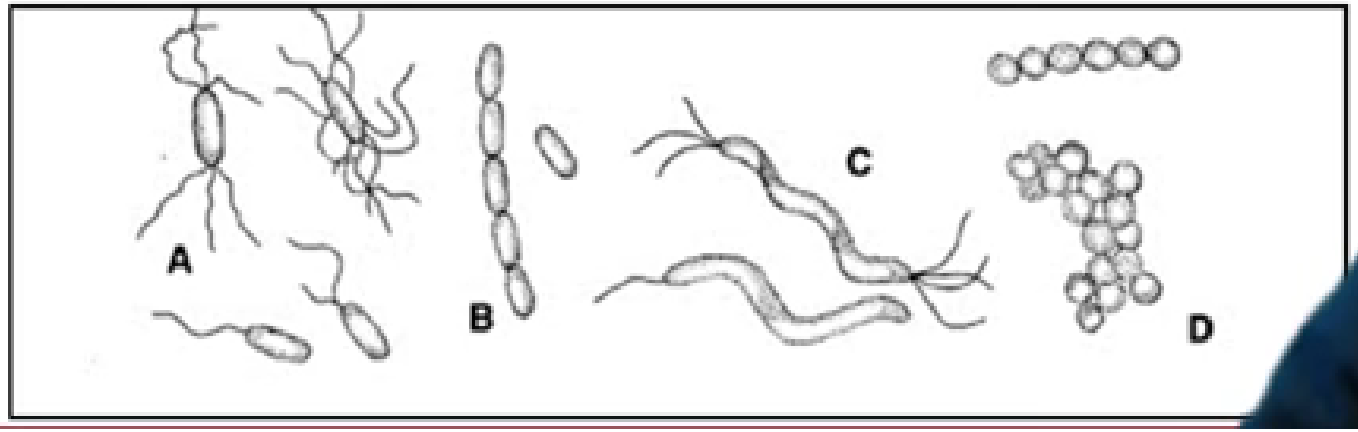
- Many grow microscopically – invest in a good hand lens
- Others will produce visible signs/growth and result in distinct symptoms



- Many produce spores that are wind or rain dispersed
- Examples: Sclerotinia stem rot, Ear rots of corn, Fusarium head scab

Bacteria

- Quite small and single celled
- Spread by water, contaminated seed, and insects
- Enter wounds or natural openings
- E.g., Goss' Wilt of Corn, Bacterial Spot of Soybean



Viruses

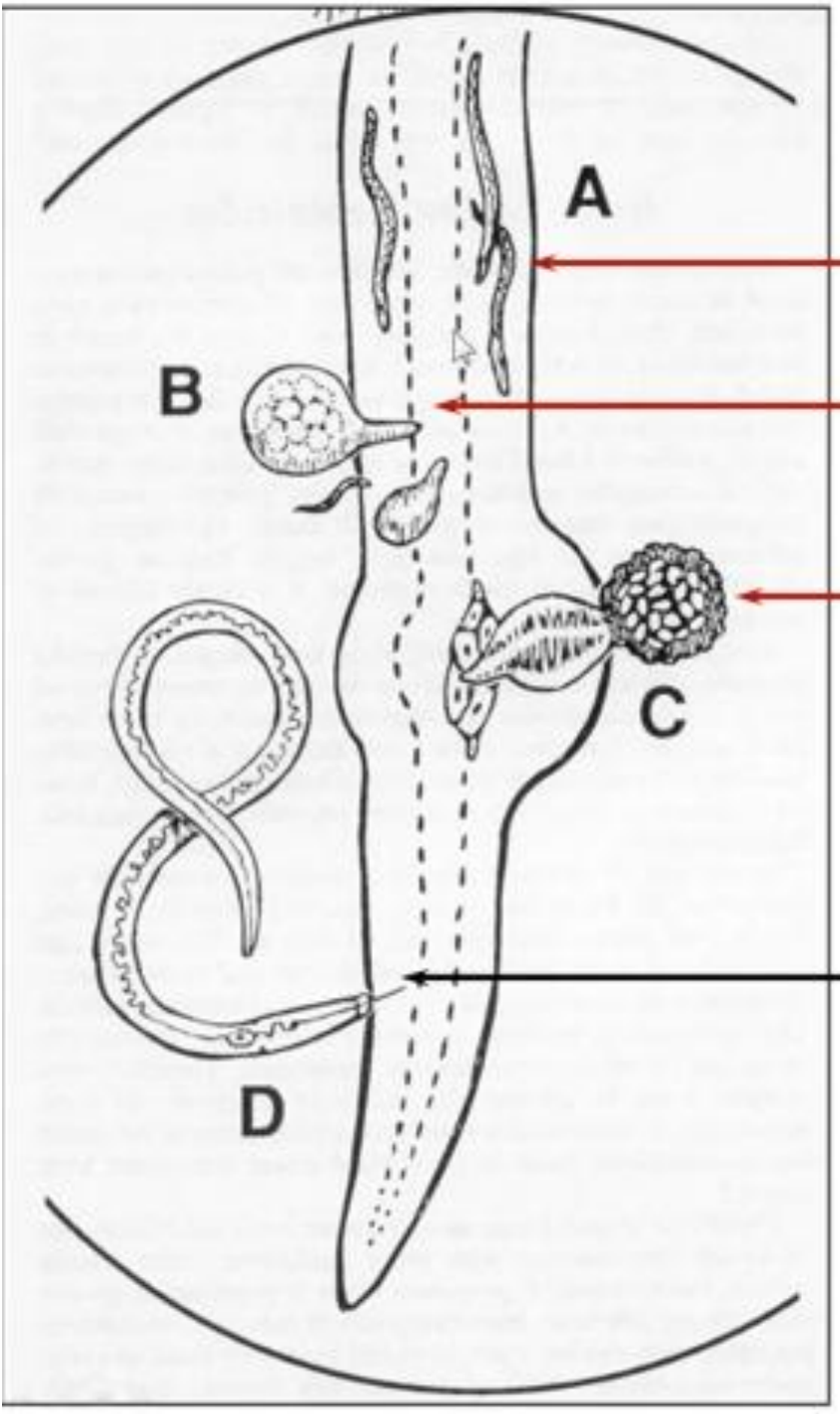
- Viruses = nucleic acid (RNA or DNA) surrounded by a protein coat
- Viewed with an electron microscope
- Shapes of particles include: rods, polyhedrons, circles
- Exist and multiply only in living tissue
  - Insect vectors
  - Nematode vectors
  - Mechanically through wounds

Viroids

- Viroids - Circular strands of RNA that occur in nuclei of infected plant cells
  - Transmitted from plant to plant via pollen, ovules, or machinery
    - Cause more than a dozen plant diseases

Potato spindle tuber viroid (first viroid to be studied by plant pathologists)

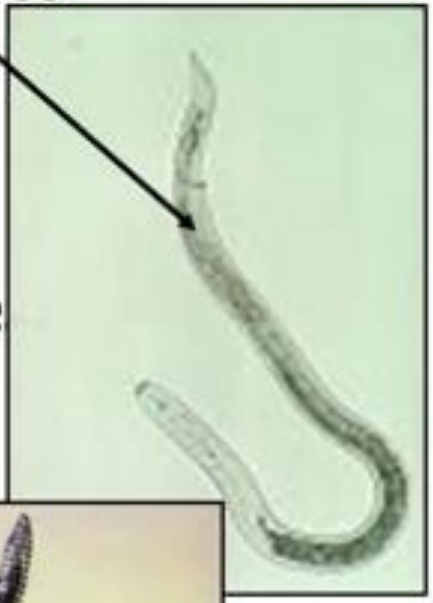
NEMATODES



Root Lesion Nematodes
Endo-migratory

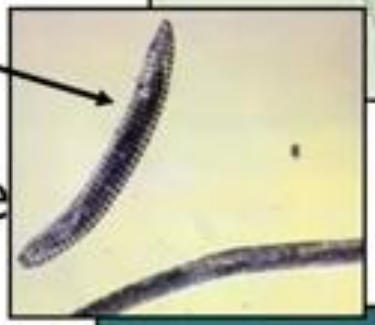
Cyst Nematodes
Ecto-sedentary

Root Knot Nematode
Endo-sedentary



Ring nematode

Sting Nematode
Ecto-migratory



Spiral Nematode

Transmission factors of microorganisms:

- Seeds, soil, air, water, insect, nematodes, shellfishes and others.
- Phytopathogenic microorganisms get into an organism of plants two ways: natural structured holes of the plant (lenticels, nectaries, and others) or traumatic surface of the different parts of the plants (as a result of mechanical, physical, biological damages).

Insects

Grasshopper

Locusts

Beetle

Bug

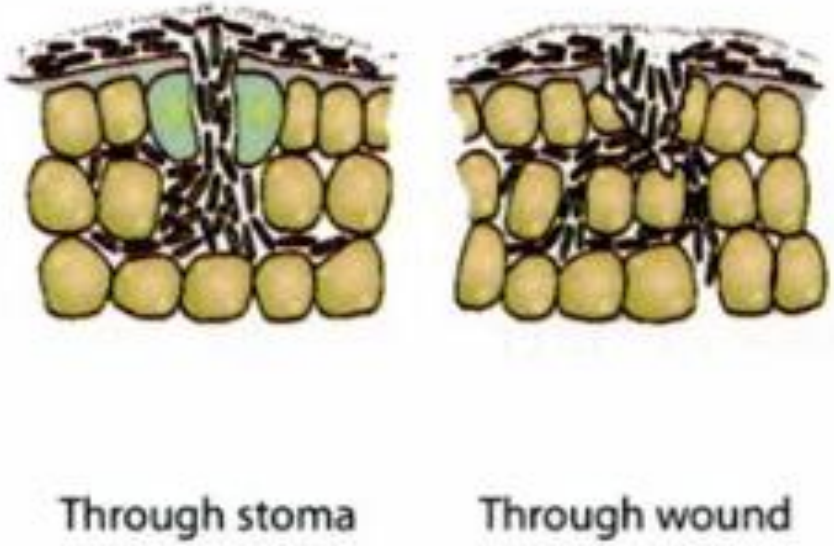
Aphids

Mites

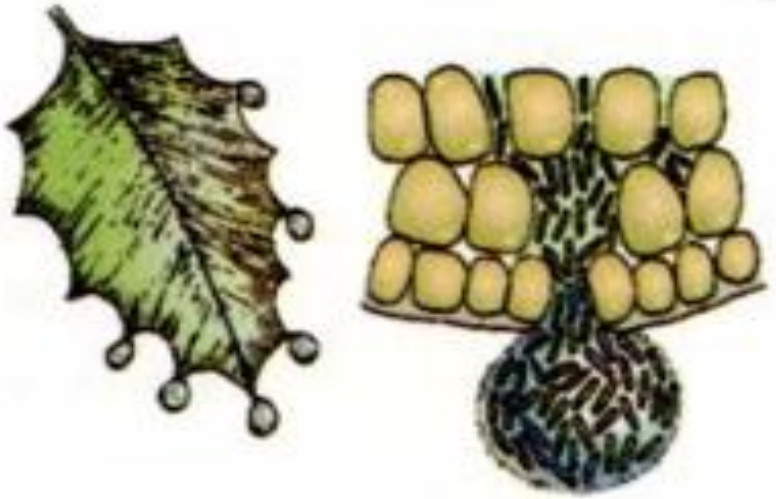
Termites

Insects damage standing crops. They some times act as carriers of certain diseases caused by bacteria and virus.

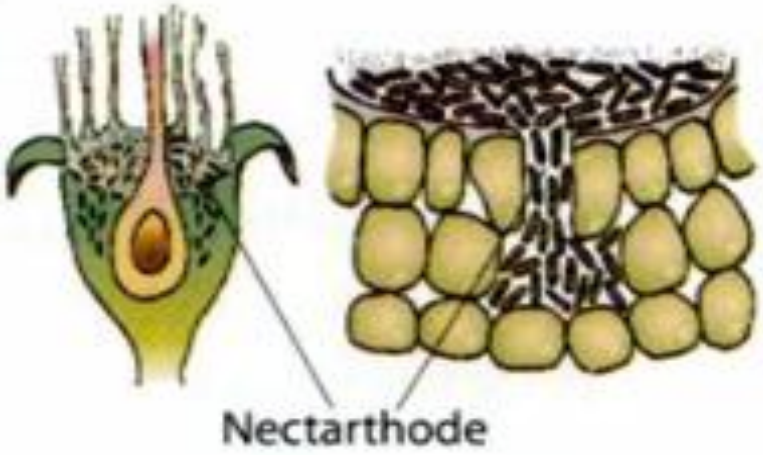
Methods of penetration and invasion by bacteria



Through stoma Through wound



Through hydathode



Bacteria in nectar and through nectarthode

bacteria are most commonly introduced into plants by wounding

Invasiveness of plant pathogens

Hydrolytic enzymes (pectinase, cellulase, proteinase). Many pathogens, principally those that produce soft-rods of plants, excrete an enzyme called protopectinase. When a slice of plant tissue is immersed in a solution of this exoenzyme, the tissue rapidly becomes macerated; that is, the cells separate and the tissue disintegrates and breach of the photosynthesis. In vivo, the protopectinase-producers are able to invade plant tissue readily as a result of this enzyme action.

Toxins

Toxins: break ferment system of the plant cell. Two very different sorts of toxins can be distinguished: exotoxins and endotoxins. The exotoxins of bacteria are heat-labile proteins, and the endotoxins of bacteria are heat-stabile, lipopolysaccharide-protein complexes. The names given to these two classes of toxins reflect the methods used for their gross detection.

The exotoxins are commonly found in solution when cultures of the microorganisms, which produce them, are grown in medium and the cells removed by filtration of centrifugation. The endotoxins, in contrast, are less readily released into the culture medium and are usually obtained by chemical extraction of the bacterial cells.

Protection factors of plants against infections

The invasiveness of plant pathogens, like that of animal pathogens, is a function of their ability to overcome host defenses. The defenses of plant hosts, however, are far simpler than those of animal hosts.

Plants do not form either phagocytes or antibodies, the two prime factors in animal defense; instead, they rely entirely **on mechanical barriers and antibacterial substances**. The latter include certain of the so-called “essential oils” and probably some specific antibiotics. The low pH of plant sap is unfavorable for the growth of many bacteria.

Protection factors of plants against infections

The cells of plants are firmly cemented together by pectic substances, principally a compound called protopectin. The molecules of these substances are long-chain polymers of galacturonic acid, a compound related to the sugar, galactose. Protopectin presents an important mechanical barrier to the potential invaders.

Sings of plant diseases

Plant diseases are evident in many ways. They attack all parts of the plant.

Plants can get diseases from the time the seed is placed in the soil until the vegetable is eaten.

It is important to identify disease symptoms quickly, so that control practices can be taken to prevent unnecessary loss.

Plants diseases are more often classified by their symptoms then by the agent of disease.

Sings of plant diseases

DAMPING OFF

NECROSIS

ETIOLATION

GALL

CHLOROSIS

Sings of plant diseases

SCAB

SCORCH

VEIN CLEARING

ANTHRACNOSE

SOOTY MOULD

Sings of plant diseases

SPOT

MOSAIC

FOLLIOCELLOSIS

SHOT HOLE

Sings of plant diseases

BLOTCH

RING SPOT

CANKER

SMUT

RUSSETTING

Agent of infectious diseases of plants

- **Mycoses:**
- Pathogens: *Penicillium, Aspergillus,* and others fungi,
- **Signs**: diseases of root system, spots on leaves, mould.
- **Bacteriases:**
- Pathogens: *Pseudomonas, Agrobacterium, Acetobacter, Erwinia,* and others,
- **Signs**: wilting, spots, rot, burns.
- **Viruses and viroids diseases of plants:**
- **Signs**: mosaic of leaf, flowers, stems, turn yellow, leafspot necrosis.
- **Mycoplasmosis:**
- **Signs**: dwarfish, abnormal growth of side stems, fertile cessation.

In plants, viruses cause stunting of growth, discoloration, distortion and abnormal formation of flowers or fruit.

Figure 2. Symptoms on pepper produced by tomato spotted wilt tospovirus. *Image courtesy H. R. Pappu,*

Mosaic virus (discoloration)

Tomato bushy stunt virus (distortion)

Fireblight

Crown Gall

Bacterial Caker

Canker

Diffuse Canker

Target-shaped Canker

Damping-Off

Anthracnose

Apple Scab

Bacterial Soft Rot on Iris

Black Knot

Botrytis Blight


Roses


Peony leaves

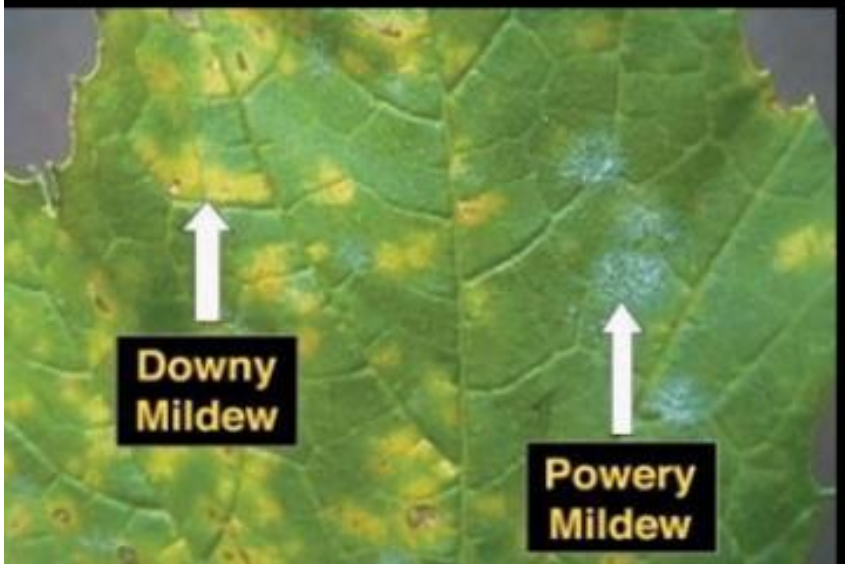

Pumpkin


Strawberries


Geranium leaf

Downy Mildew

Grape



Powdery Mildew

Phytophthora Root Root

Phytophthora

Cedar-Apple Rust

On Juniper

On Apple

dar-Apple Rust

Brown Rot

Control of diseases of plants

Plant diseases are controlled by methods of **cultivation** (e.g., crop rotation and the plowing under or burning of crop residue);

by **application of chemicals**, e.g., fertilizers (to correct mineral deficiencies in the soil), spray or dust fungicides, bactericides, and insecticides;

by **development of disease-resistant strains by genetic methods**;

by use of **alternative species** that are not susceptible to the disease;

by eradication of diseased plants or of their alternate hosts (e.g., barberries, which harbor wheat-stem rust); and

by **quarantine measures** by state and federal governments to prevent the introduction of foreign plant diseases.

Field and orchard crops are more susceptible to destruction than are wild plants, because the close proximity of large numbers of a single species (monoculture) makes possible the rapid spread of disease to epidemic proportions.

Most biocontrol agents apply only one of these four mechanisms, however, some may employ more than one:

- Direct competition with the target organism. In this case the biocontrol agents out completes the target organisms for nutrients and space.
- Antibiotics. With antibiosis, the biocontrol agent produces an chemical compound such as an antibiotic or some type of toxin that kills or has some sort of detrimental effect on the target organism.

- Predation or parasitism of the target organism. In this case the biocontrol agent can attack and feed directly on the target organism or the biocontrol agent can produce some sort of toxin that kills the target organism and then the biocontrol agent feeds on the dead target.
- Induced resistance of the host plant. It has been known for decades that once a plant is infected with a pathogen, that infection triggers some sort of reaction in the infected host plan that helps keep it from being infected with other pathogens. The infected plant becomes more “resistant” to other infections.

Advantages of using biocontrols

- They help reduce the use of chemical-based fungicides.
- They help reduce the risk of developing pathogen resistant to traditional chemicals.
- In most cases they are safer to use.
- They tend to be more stable then chemical pesticides if stored properly.
- In most cases they have lower re-entry interval (R.E.I.) times.
- In most cases they are less phytotoxic.

Disadvantages of biocontrol

- Biocontrol agent tend to be more difficult to implement when compared to chemicals.
- In most cases they have a narrower target range. Most are not broad spectrum products.
- They may not work as quickly as chemicals.
- These products do not eradicate the pathogen or rescue the host from infection.
- They may have a shorter shelf life if not stored properly.
- In most cases biocontrol products are more expensive to use.
- They may not be compatible with the use of other chemical fungicides and bactericides.

Disease Control of plants

In the order for any of these biological control agents to work for you, two simple rules must be followed. First off, all of these products must be used in conjunction with standard disease cultural controls.

Cultural controls include, growing plants in a well-drained media, not over watering, keeping the greenhouse relative humidity below 85%, practicing strict sanitation, and making sure that the nutrient and pH conditions of the host plant a within the ideal range for proper growth and development. Secondly, all of these biocontrol products must be applied prior to the onset of disease.

Methods of the microbiological control of medicinal raw materials and medicines

- The medicinal raw materials can be contaminating with microorganism. The level of microbial contamination depends foe its origin, conditions of preparation and storage. During drying of medicinal herbs the most part of microorganisms are dead. But if don’t observe the rules of storage of medicinal herbs, another microorganisms multiply and use medicinal raw materials as nutritional media.

Methods of the microbiological control of medicinal raw materials and medicines

- The medicines can become soiled by microorganisms during preparation (primary contamination), storage and using (secondary contamination). Sources of microbial pollution of medicines are raw material, water, air, packing and packing material, chemist's and factory equipment, the hands and clothes of the personnel. The microorganisms have wide set enzymes, and decompose pharmacology active substations using as nutritious. Liquid and soft medicines with natural compositions are most contaminated. Except for saprophytes, the medicines can be contaminate pathogenic microorganisms and sick human may be infect by these pathogenic microorganism.

Signs of Microbial Spoilage of Medicines

- For liquid forms is discoloration, dimness, tape, sediment, not typical smell.
- For soft forms is stratification, growing mouldy, formation of suds.
- For hard forms is a change consistency, colors.

Requirement of Pharmacopoeia to Medicinal Preparations

The must sterile be preparations:

1. For parenterally application (injections, infusions);
2. Ophthalmologic (drops, ointments, tapes) and others;
3. For application in the cavity of body, where in a norm a microflora absents (uterus, urinary bladder, middle ear and others).

There are requirement to microbial purity of non-sterile medicines

- The non-sterile medicines must not contain bacteria from family *Enterobacteriaceae, Staphylococcus aureus, Pseudomonas aeruginosa;*
- The non-sterile medicines for local, transdermal, intravaginal using and also in an ear cavity, nose cavity, mouth cavity, for inhalation, must contain no more than 10^2 bacteria and fungi (yeast and molds) totally in *1 g* (ml);
- The non-sterile medicines for taking internally must contain no more than 10^3 bacteria and no more than 10^3 fungi (yeast and molds) in *1 g* (ml);

There are requirement to microbial purity of non-sterile medicines

- The non-sterile medicines for taking internally (for children in the age of till 1 year) must contain no more than 50 bacteria and fungi (yeast and molds) totally in 1g (ml);
- The non-sterile medicines for taking internally (for children in the age elder than 1 year) must contain no more than 500 bacteria and 50 fungi (yeast and molds) in 1g (ml);
- The level of microbial contamination of medicinal raw materials must not exceed the level of microbial contamination of medicines.

Prevention of Microbial Contamination of Preparations:

observance of rules of sanitary-disease mode in process of making of medicinal preparations and organization of production in accordance with the rules of GMP.

Thank you for attention!