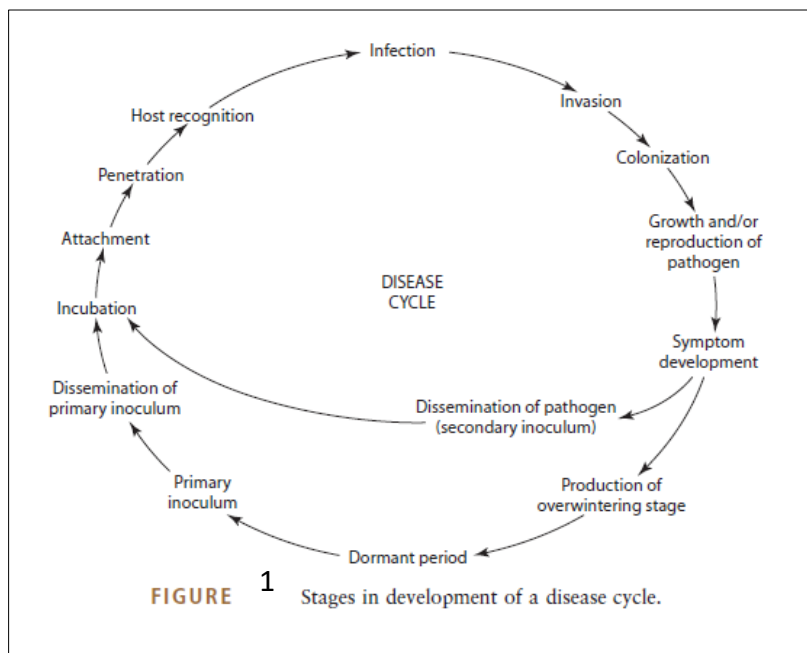


## How Pathogens Cause Disease in Trees

### The Disease Cycle

A Series of events occurs in succession and leads to the development of disease. This chain of events is called the disease cycle. Plant disease cycles represent pathogen biology as a series of interconnected stages of development including dormancy, reproduction, dispersal, and pathogenesis.



**Stages in the development of disease:** in the disease cycle;

1. Inoculation
2. Penetration
3. Infection
4. Invasion
5. Reproduction
6. Dissemination
7. Survival

**1-Inoculation;** is the initial contact of the pathogen with a site of the plant where infection is possible. The pathogen that is brought into contact with a plant is called inoculum. Inoculum is any part of a pathogen that can initiate infection.

Types of inoculum

A-Primary inoculums

Inoculum that survives dormant in winter or summer and causes original infection in spring or autumn is called primary inoculum.

B-Secondary inoculums

Inoculum produced from primary infection.

Source of Inoculum:

- ✓ Soil: Bacteria, fungus, nematodes
- ✓ Infected plant parts: Seed, cuttings, bulbs, corns, tubers etc.
- ✓ Diseased debris
- ✓ Alternate hosts

**2-Penetration**

Pathogens penetrate plant surfaces by direct penetration by cell walls, natural openings (Hydathodes and Lenticels), and through wounds.

## **How Pathogenic Fungi Enter the Tree**

### **Fungi**

Infectious disease, regardless of pathogen, is a dynamic process involving the interaction of the tree, the pathogen, and the environment. Fungi that can attack woody plants are always at hand, ready and waiting, in the soil, on the bark, and in the air around trees. As the pathogenic fungus attempts to overcome the tree's defences, the environmental conditions usually favour either the pathogen or the host.

Some fungi enter the plant by growing through natural openings (stomates and lenticels), while other kinds can penetrate directly into the host tissues. However, a large number of fungi can gain entrance into a plant only through wounds. Many people do not realise that even very small wounds, such as those from nails driven into a tree, can permit serious diseases to occur in the tree.

Avoid wounding trees and give immediate, careful attention to fresh wounds! These practices will prevent most infections by fungi on trees and will prevent most infections by other pathogenic microorganisms as well.

Overall, pathogens penetrate plant surfaces by direct penetration of cell walls, through natural openings, or wounds. Most fungi spread into all the tissues of the plant organs (leaves, stems, and roots) they infect, either by growing directly through the cells as an **intracellular mycelium** or by growing between the cells as an **intercellular mycelium**.

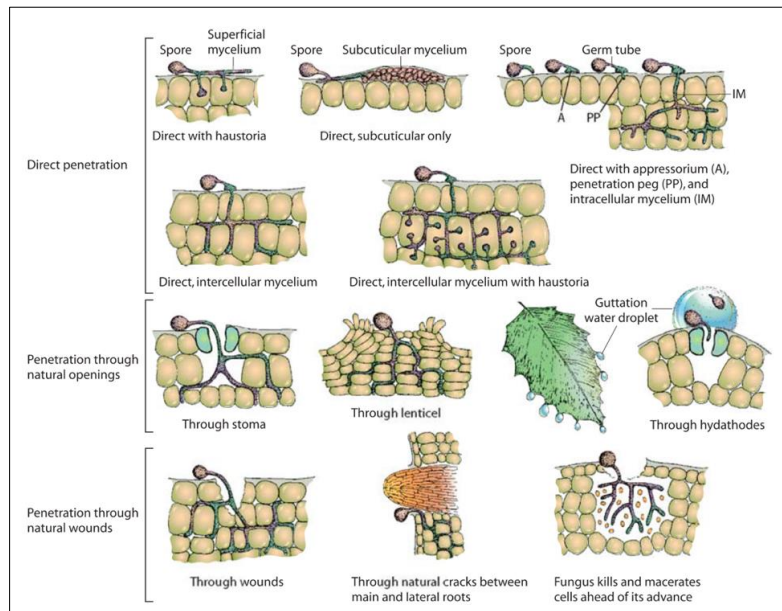


Fig 2. Methods of penetration and invasion by fungi

## Bacteria

### How Bacteria Cause Disease In Trees

Bacteria do not have any structures to allow them to penetrate directly into plant tissue. Being so small, however, they can enter through natural openings in the plant such as stomates, lenticels, openings at ends of leaf veins (hydathodes), and glands in flower (nectaries). Wounds are a major site of infection by bacteria, as with fungi. Wounding from pruning, grafting, mechanical injuries, and insects can commonly result in the infection of shade trees with bacteria. Bacteria usually

are on plant surfaces as contaminants and so they are present when the wound occurs. They also can contaminate the wounding agents such as pruning and grafting tools or insects and thereby can enter every plant that is wounded.

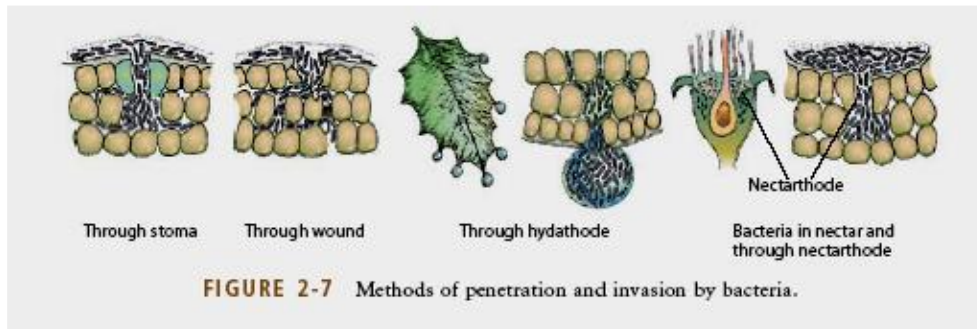


Fig 3. Methods of penetration and invasion by Bacteria

### 3-Infection

Infection is the process by which pathogens establish contact with susceptible cells or tissues of the host and procure nutrients from them.

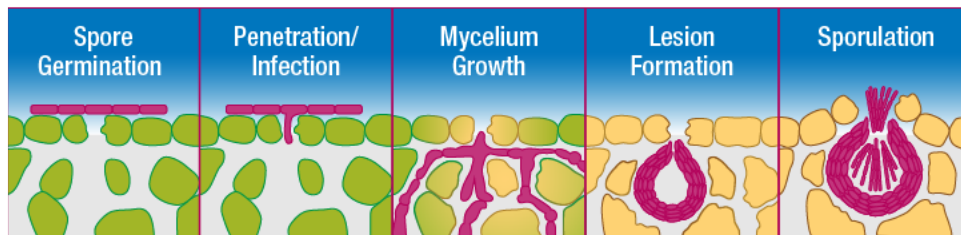


Fig 4. Fungal infection and development

### 4-Invasion

After infection, the pathogen invades the hosts. e.g. Pathogen pathogen-causing powdery mildew produces mycelium only on the surface of the plant but sends haustoria into epidermal cells

### 5-Reproduction

Plant pathogens can reproduce sexually and asexually. It is dependent on the pathogen.

### Dissemination of the Pathogen

**Dissemination of the Pathogen:** A few pathogens, such as nematodes, oomycetes, zoosporic fungi, and bacteria, can move short distances on their power and thus can move from one host to another one very close to it. Fungal hyphae

can grow between tissues in contact and sometimes through the soil toward nearby roots for a few to many centimetres.

**1-Dissemination by air,** water, insects, mites, nematodes, other vectors, pollen, seed, transplants, nursery stock and humans.

**2-Dissemination by water:** Water is important in disseminating pathogens in three ways. Bacteria, nematodes, spores and mycelial fragments of fungi present in the soil are disseminated by rain or irrigation water that moves on the surface or through the soil.

**3-Dissemination by insects, mites, nematodes and other vectors:** Insects, particularly aphids, leafhoppers, and whiteflies, are by far the most important vectors of viruses, whereas leafhoppers are the main vectors of mollicutes, fastidious bacteria, and protozoa. Each one of these pathogens is transmitted, internally, by only one or a few species of insects during the feeding and movement of the insect vectors from plant to plant.

**4-Dissemination by humans:** Human beings disseminate all kinds of pathogens over short and long distances in various ways. Such as:

- Through the successive handling of diseased and healthy plants.
- Through tools.
- Transporting contaminated soil on their feet or equipment, using contaminated containers, and using infected transplants, seeds, nursery stock, and budwood.

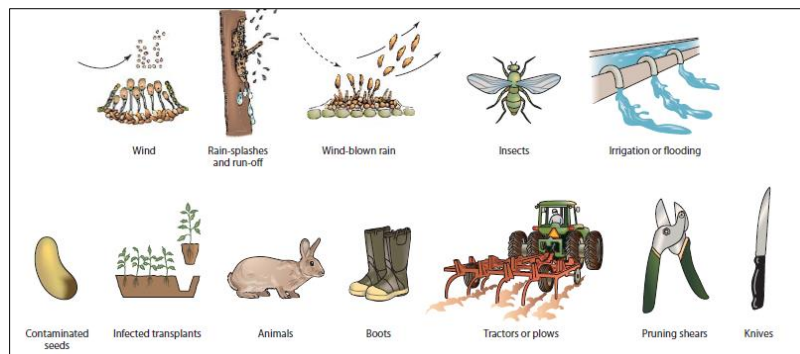


Fig 5. Means of dissemination of Pathogens