

# Plant Pathology

# Introduction Of Plant Pathology

Phytopathology (**Greek Phyton = plant + pathos - suffering + logos = to Study/ knowledge**) is the branch of agricultural, botanical or biological science which deals with the cause, etiology, resulting in losses and management methods of plant diseases.

# Etiology

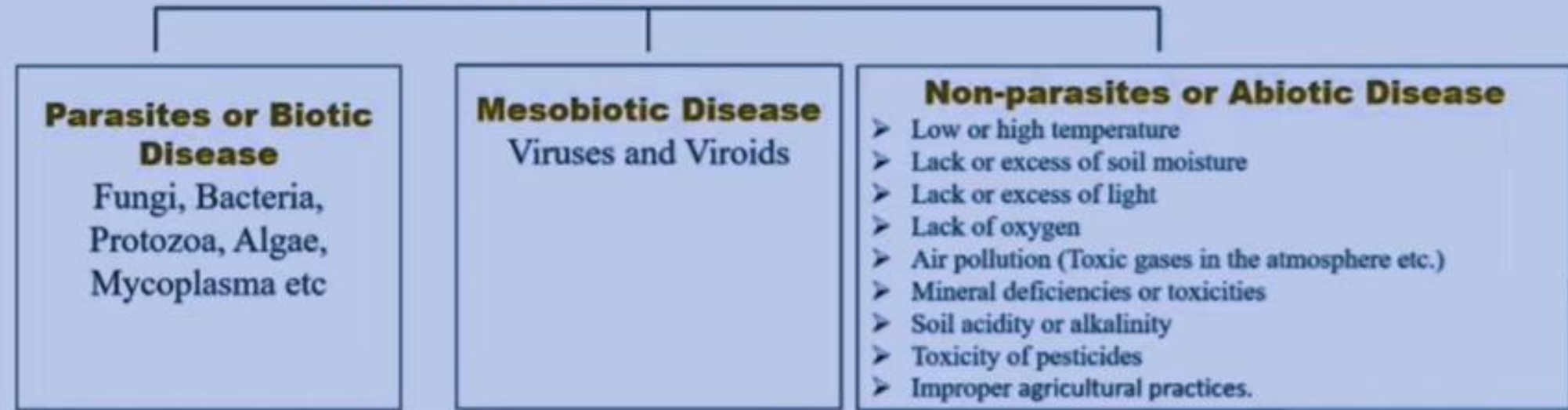
The scientific study of the causes of disease

रोगों के कारणों का अध्ययन करने वाला शास्त्र; रोगहेतु विज्ञान

# Terminology Related to Plant Pathology

**1- Plant Disease:** A physiological disorder or structural abnormality that is harmful to the plant or only its parts or products that reduced the economic value.

## Types of Disease



# Terminology Related to Plant Pathology

- 2 - Disease Severity :** The measure of damage done by a disease. OR Amount of disease present in a population. E.g. Leaf, stem, seed diseases.
- 3 - Disease Incidence :** the number of plants affected by a disease within a population. E.g. soil borne diseases, nematodes.



# Terminology Related to Plant Pathology

- 4 - Pathogenicity:** The capacity of a pathogen to cause disease.
- 5 - Pathogenesis:** is the chain of events that lead to development of disease in the host (or) sequence of progress in disease development from the initial contact between the pathogen and its host to the completion of the syndrome.

# Terminology Related to Plant Pathology

- 6 - Sign:** The pathogen or its parts or products seen on a host plant.
- 7 - Symptom:** The external or internal reactions or alterations of a plant as a result of a disease.
- 8 - Syndrome:** The set of varying symptoms characterizing a disease are collectively called a syndrome. OR The series of symptoms of a disease collectively known as syndrome.



# Terminology Related to Plant Pathology

**9 - Virulence:** The degree of pathogenicity of a given pathogen.

**10 - Virulent:** Capable of causing a severe disease; strongly pathogenic.

**11 - Avirulent (non-virulent):** Non-pathogenic or lacking virulence.

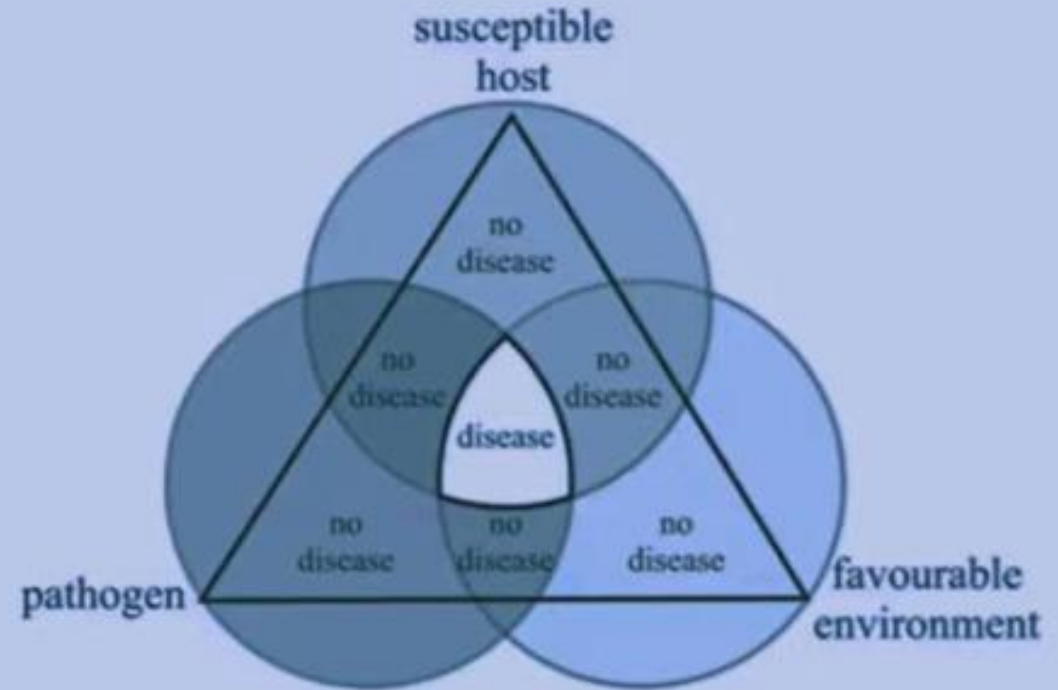
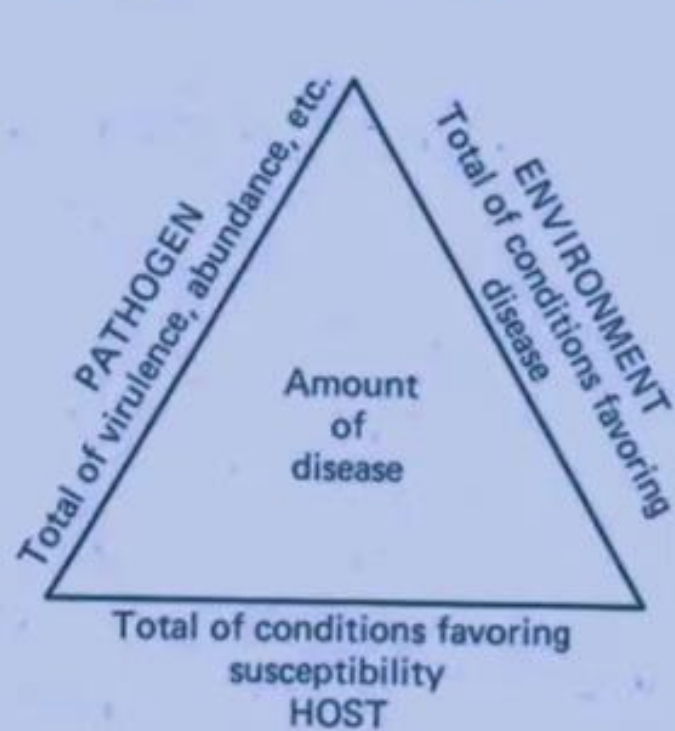


# Terminology Related to Plant Pathology

- 12 -Infection:** The establishment of a parasite within a host plant.
- 13 -Latent Infection:** where the host is infected with a pathogen but does not show any symptoms.
- 14 - Infectious disease:** A disease that is caused by a pathogen which can spread or transfer from a diseased to a healthy plant.
- 15 -Non-infectious disease:** A disease that is caused by an abiotic agent, that is, by an environmental factor, not by a pathogen.

# Terminology Related to Plant Pathology

## 16 - Diseases Triangle



# **Infection process / disease cycle (Plant Pathology)**

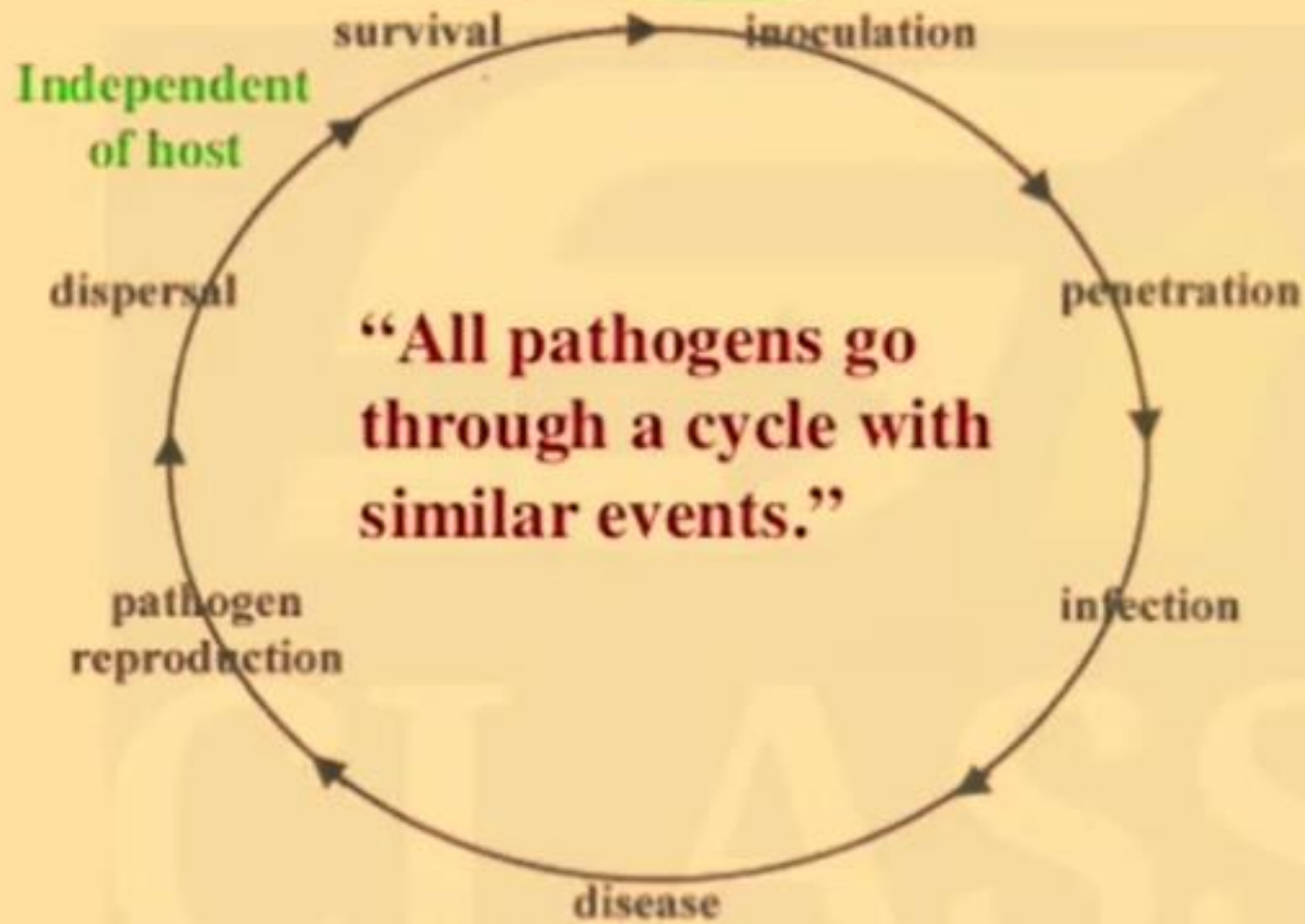
# INTRODUCTION

In every infectious disease, a series of more or less distinct events occurs in succession which leads to the development of the disease. This chain of events is called Pathogenesis or disease cycle.

# Primary Events in the Disease Cycle

- i) Inoculation
- ii) Penetration
- iii) Establishment of the infection
- iv) Colonization (invasion)
- v) Growth and reproduction of the pathogen
- vi) Dissemination of the pathogen
- vii) Survival of the pathogen in the absence of the host i.e. overwintering and over-summering (over-seasoning) of the pathogen

# Disease Cycles



**Inoculum:** The pathogen or its parts that can cause infection. That portion of individual pathogens that are brought into contact with the host.

**Inoculum potential:** Which consists of the number of propagules and their capacity to cause infection.

**Inoculate:** To bring a pathogen into contact with a host plant or plant organ.

**Inoculation:** The arrival or transfer of a pathogen onto a host.

**Penetration:** The initial invasion of a host by a pathogen.

**Primary infection:** The first infection of a plant by the overwintering or over summering pathogen.

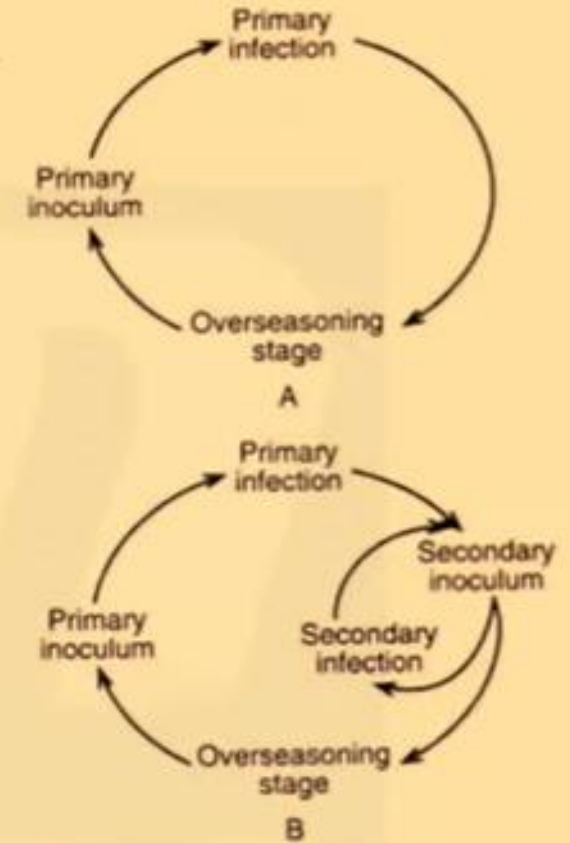
**Primary inoculum:** The overwintering or over summering pathogen, or its spores that cause primary infection.

**Secondary infection:** Any infection caused by inoculum produced as a result of a primary or a subsequent infection. OR An infection caused by secondary inoculum.

**Secondary inoculum:** Inoculum produced by infections that took place during the same growing season.



# Disease Cycles



Diagrammatic representation of disease cycle :  
A. Monocyclic, and B. Polycyclic

# INFECTION AND INVASION

## Infection

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

Invasion of plant tissues by the pathogen, and growth and reproduction of the pathogen (colonization) are two concurrent stages of disease development.

# Growth and reproduction (colonization) of the pathogen

► After infection, pathogens grow, multiply or both within the plant tissues and invade and colonize the plant to a lesser or greater extent.

Plant pathogens reproduce in a variety of ways.

- i) Fungi reproduce by means of spores, either asexually or sexually.
- ii) Parasitic higher plants produce seeds.
- iii) Bacteria and phytoplasma reproduce by fission in which one mature individual splits into two equal, smaller individuals.
- iv) Viruses and viroids are replicated inside the host cells.

# **CLASSIFICATION OF PLANT DISEASES**

# Classification of Plant Disease

- A) On the basis of mode of perpetuation and primary infection:
- B) On the basis of infectious nature:
- C) On the basis of production and spread of the inoculum or number of pathogen generations
- D) On the basis of extent of plant parts affected:
- E) On the basis of Cause of the disease:
- F) On the basis of occurrence and geographic distribution:
- G) On the basis of plant part affected:
- H) On the basis of crop plants affected:
- I) On the basis of symptoms produced on host plants:

A) On the basis of mode of perpetuation and primary infection:

- 1) Soil borne diseases:
- the pathogens survive in soil or on infested plant debris lying in soil either as their resting spores or as mycelia strands and rhizomorphs.
- They all attack the root system of host plants.
- Eg: Damping off (*Pythium* sp.), Seedling blight (*Phytophthora*, *Fusarium* sp.)

A) On the basis of mode of perpetuation and primary infection:

- 2) Air borne diseases:
  - Some pathogens infects the host plant through air and bring primary as well as secondary infection.
  - Eg: Rusts, Powdery mildews.
- 3) Seed borne diseases:
  - Some pathogens survive as dormant mycelium or other propagative structures in the seeds of host plants.
  - Eg. Loose smut of wheat (internally seed borne)

## B) On the basis of infectious nature:

- **1) Infectious plant diseases:** These diseases are caused by living agents, the pathogen. All pathogens are parasitic on plants. These are characterised by the ability of the pathogen to grow and multiply rapidly.
  - Ex: Powdery mildews, Rusts.
- **2) Non-infectious diseases:** These diseases do not spread from plant to plant (non-infectious). These diseases are caused due to abiotic factors (non parasitic or physiological).
  - Eg: Black heart of potato.



### C) On the basis of production and spread of the inoculum or number of pathogen generations:

- 1) **Single cycle disease or simple interest disease or Monocyclic:**
  - the increase of disease is mathematically analogous to simple interest disease.
  - those diseases which have only generation in one cropping season
  - e.g. loose smut of wheat.
- 2) **Multiple cycle or compound interest disease or Polycyclic:**
  - the increase in disease is mathematically analogous to compound interest of money.
  - those diseases which have more than one generation in a cropping season
  - e.g. late blight of potato

C) On the basis of production and spread of the inoculum or number of pathogen generations:

- ▶ 3) Polyetic diseases: These are also polycyclic diseases but they complete their disease cycle in more than one year
- ▶ Eg.: Cedar Apple Rust

## D) On the basis of extent of plant parts affected:

- ▶ 1) **Localized**: If they affect only specific organs or parts of the plants.
  - ▶ Eg.: Root Rot, Leaf spot.
- ▶ 2) **Systemic**: If entire plant is affected.
  - ▶ Eg.: Downy mildew, damping off.



## E) On the basis of Cause of the disease:

- ▶ (i) Biotic disease
  - ▶ (ii) Mesobiotic disease
  - ▶ (iii) Abiotic disease
- 
- ▶ 1) **Fungal disease**: Caused by plant pathogenic fungi. Eg. Anthracnose
  - ▶ 2) **Bacterial disease**: Caused by plant pathogenic bacteria. Example: Citrus canker
  - ▶ 3) **Phytoplasma disease**: Caused by Phytoplasma. Eg. Aster yellow
  - ▶ 4) **Phanerogamic phytopathogenic diseases**: Caused by phanerogamic plant parasites. Eg. Striga, Cuscutta.
  - ▶ 5) **Nematode Diseases**: Diseases caused by plant pathogenic nematodes.
  - ▶ Eg. Ear cocle of wheat.

## E) On the basis of Cause of the disease:

- ▶ (ii) Mesobiotic disease - Disease caused by Virus and Viroid
- ▶ (iii) Abiotic disease - by Abnormal environmental condition

## F) On the basis of occurrence and geographic distribution:

- Epidemic or Epiphytotic disease:
- A disease usually occurs widely but periodically in a destructive form is referred as epidemic or Epiphytotic disease.
- Ex: Late blight of potato - Irish famine (1845)

- Endemic:

- Constantly present in a moderate to severe form and is confined to a particular country or district.
- Ex: Club root of cabbage in Nilgiris
- Black wart of potato - *Synchytrium endobioticum*
- Onion smut - *Urocystis cepulae*



- Sporadic disease:
- Occur at very irregular intervals and locations and in relatively fewer instances.
- Ex: Udbatta disease of rice,
- Angular leaf spot of cucumber

- Pandemic disease:
- an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of population”
- Ex: Wheat rust UG99

## G) On the basis of organs / plant part affected:

- ▶ 1) **Fruit diseases:** In these diseases fruits are mainly affected Eg. Apple scab. (*Venturia inaequalis*)
- ▶ 2) **Root diseases:** In these disease, root is mainly affected. Eg. Root rot of papaya. (*Pythium aphanidermatum*)
- ▶ 3) **Leaf diseases:** Disease is localised in the foliage. Eg. Leaf spot of cotton. ( *Alternaria gossypii* (Jacz.)
- ▶ 4) **Seedling diseases:** Seedlings are affected in which stem and root tissues rot. Eg. Damping off of seedling. (*Rhizoctonia sp.*)

## H) On the basis of crop plants affected:

- ▶ 1) **Cereal diseases:** Disease which affect cereal crops eg. Wheat, barley and oat.
- ▶ 2) **Pulses diseases:** Diseases which affect pulses crop. Ascochyta blight of chickpea.
- ▶ 3) **Millet diseases:** Diseases which affect millets. Eg. Green ear disease of Bajra.

- ▶ 4) **Vegetable diseases** : Diseases which affect vegetable crops. Eg. Early blight of Tomato caused by *Altrnaria solani*
- ▶ 5) **Fruits diseases** : Diseases affect fruit crops. Eg. Apple Scab
- ▶ 6) **Ornamental plant diseases**: Diseases affecting ornamental plants. Eg. Chrysanthemum stunt.
- ▶ 7) **Forest diseases**: Diseases affecting forest trees and plantation. Eg. Sudden Oak Death (*Phytophthora ramorum*)

1) On the basis of symptoms produced on host plants:

# 1. Downy mildews

- ▶ Symptoms appear as yellow to white patches on the upper surfaces of older leaves.
- ▶ This disease is caused by family Peronosporaceae
- ▶ Eg. DMD of Grapevine



## 2. Powdery mildews

- ▶ Symptoms appear as white powdery mass on upper surface of leaves, inflorescence.
- ▶ Eg. Mango powdery mildew, Pea PMD





### 3. Leaf Curls:

- ▶ curling, thickening & distortion of leaves
- ▶ e.g. Peach Leaf Curl, Tomato leaf curl by Virus



## 4. Galls:

- ▶ Enlarged parts of plant organs, usually caused by excessive multiplication or enlargement of plant cells
- ▶ E.g. Clubroot - (*Plasmodiophora brassicae*) enlarged roots
- ▶ bacterial galls by *Agrobacterium*



## 5. Scab:

- ▶ A roughened, crust-like diseased area on the surface of a plant organ; a disease in which such areas form.
- ▶ e.g. Apple Scab (*Venturia inaequalis*) and Pear Scab (*Venturia pirina*)



## 6. Dieback:

- ▶ progressive death of shoots and twigs generally starting at the tip of the infected plant part
- ▶ e.g. Shoot Dieback of Apple



## 7. Anthracnose:

- ▶ an ulcer-like lesion that can be necrotic and sunken.
- ▶ These lesions can appear on the fruit, flowers and stems of the host
- ▶ e.g. Bean Anthracnose



## 8. Damping Off:

- ▶ it is a rapid collapse and death of very young seedling.
- ▶ Either the seed rots before emergence or the seedling rots at the soil line and falls over and dies.
- ▶ The most common genera involved are Fusarium, Rhizoctonia and Pythium



## 9. Rots:

- rotting and disintegration of flesh, leaves, roots, tubers and fruit
- e.g. Phytophthora Root Rot



## 10. Leaf Spot:

- ▶ A self-limiting necrotic lesion on a leaf.
- ▶ Eg. Septoria leaf spot in tomato





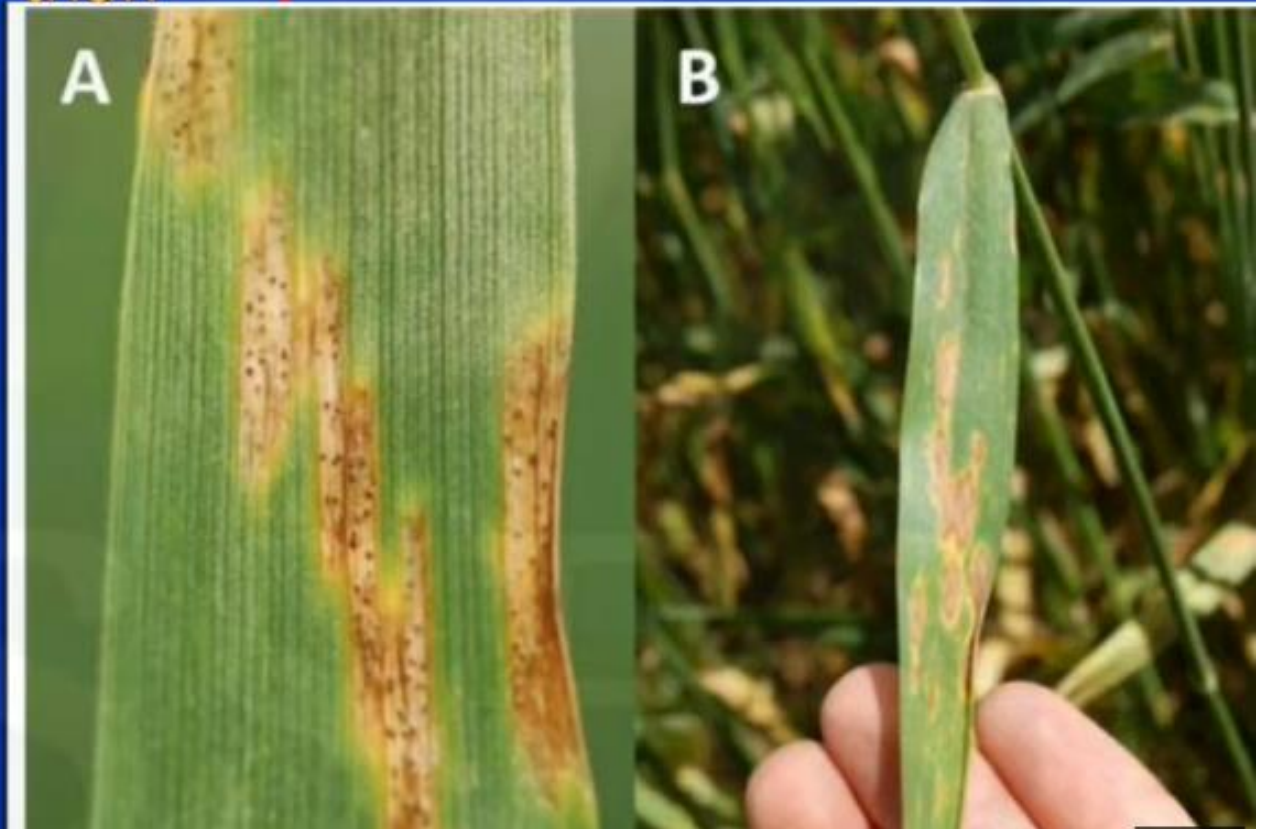
## 11. Blight:

- rapid generalized browning and death of leaves, floral organs, stems and branches.
- Blossom Blight (*Monilinia fructicola*)
- Tomato Early Blight
- Potato Late Blight



## 12. Spot Blotch:

- ▶ Necrosis of leaf tissue which is generally larger than leaf spot but smaller than leaf blight.
- ▶ Spot blotch of wheat
- ▶ Septoria blotch of wheat



## 13. Canker:

- ▶ A necrotic, often sunken, lesion on a stem, branch, fruits or twig of a plant.
- ▶ Citrus canker



## 14. Rust:

- ▶ A disease giving a “rusty” appearance to a plant.
- ▶ Wheat rust



## 15. Smut:

- ▶ Grains / seeds of plant converted in to black powdery masses.
- ▶ Wheat smut



## 16. Wilt:

- ▶ Loss of rigidity and drooping of plant parts, generally caused by insufficient water in the plant.
- ▶ Banana wilt

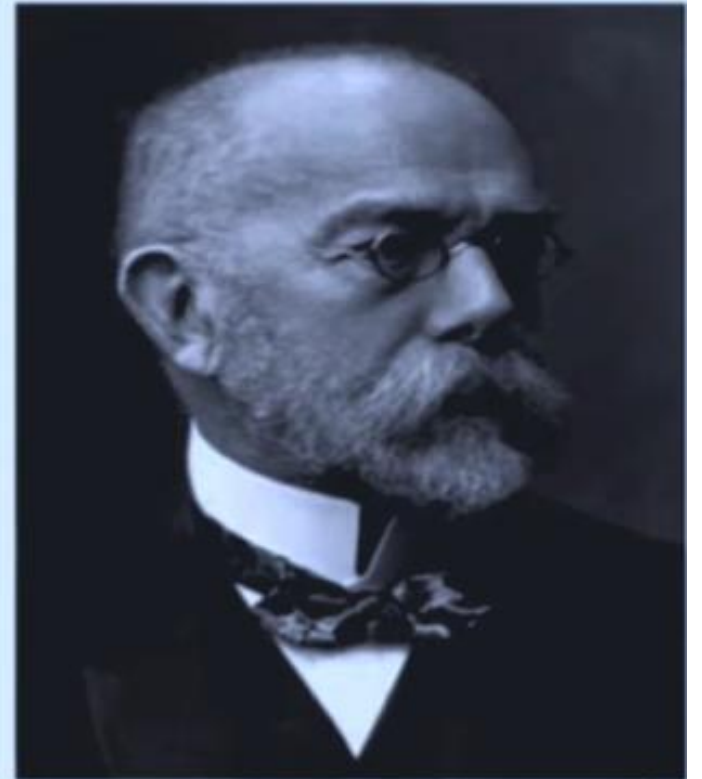


# **KOCH's POSTULATES**

# KOCH'S POSTULATES

Robert Koch- Medical Doctor and Bacteriologist was the first to show (1876) that **Anthrax**, a disease of sheep was caused by a bacterium *Bacillus anthracis*.

He also discovered that tuberculosis and cholera are caused by different bacterium.



**Robert Koch (1843 - 1910)**



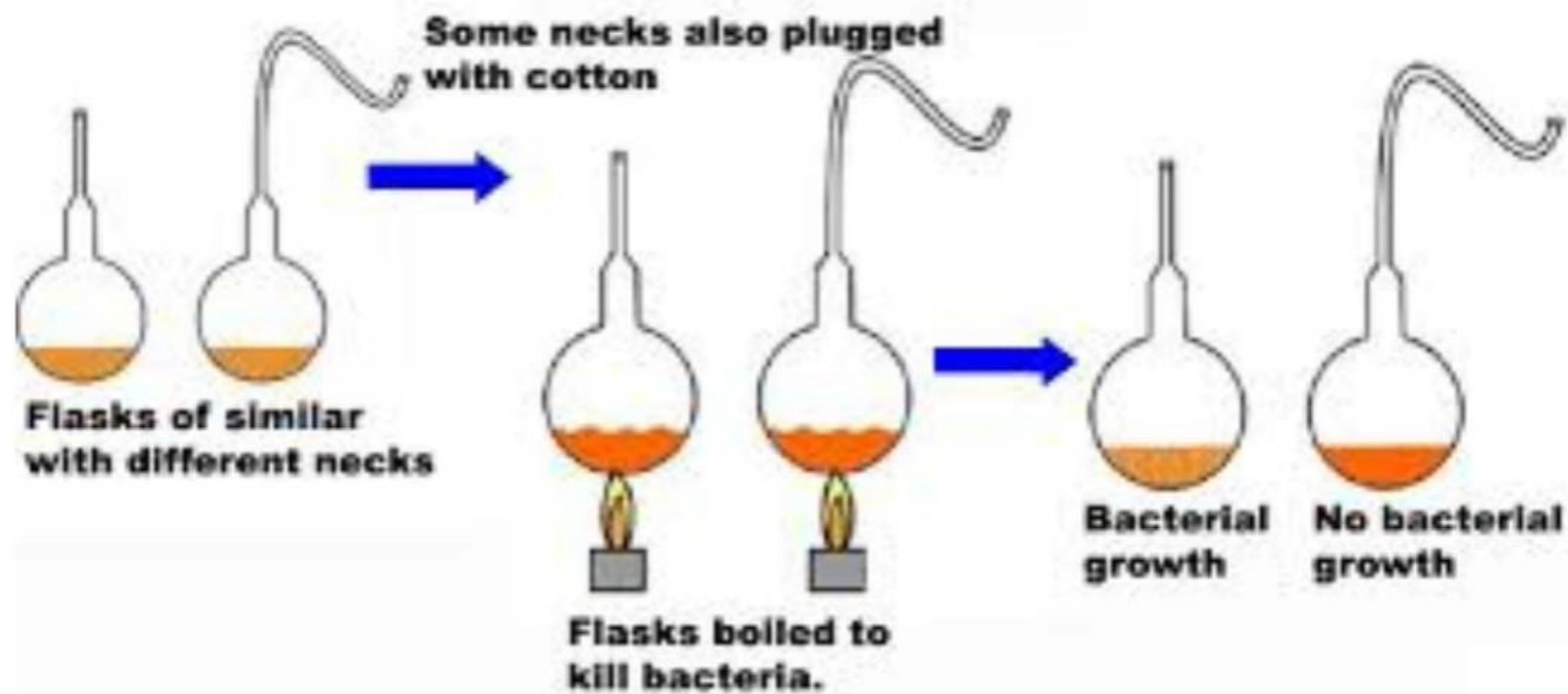
# Spontaneous Generation

- Before the 17<sup>th</sup> century, people believed that living things could come from nonliving things.
  - The Cell Theory has not been written.

Example: Rotting meat → Maggot



- ▶ Biogenesis – Living things come from other living things



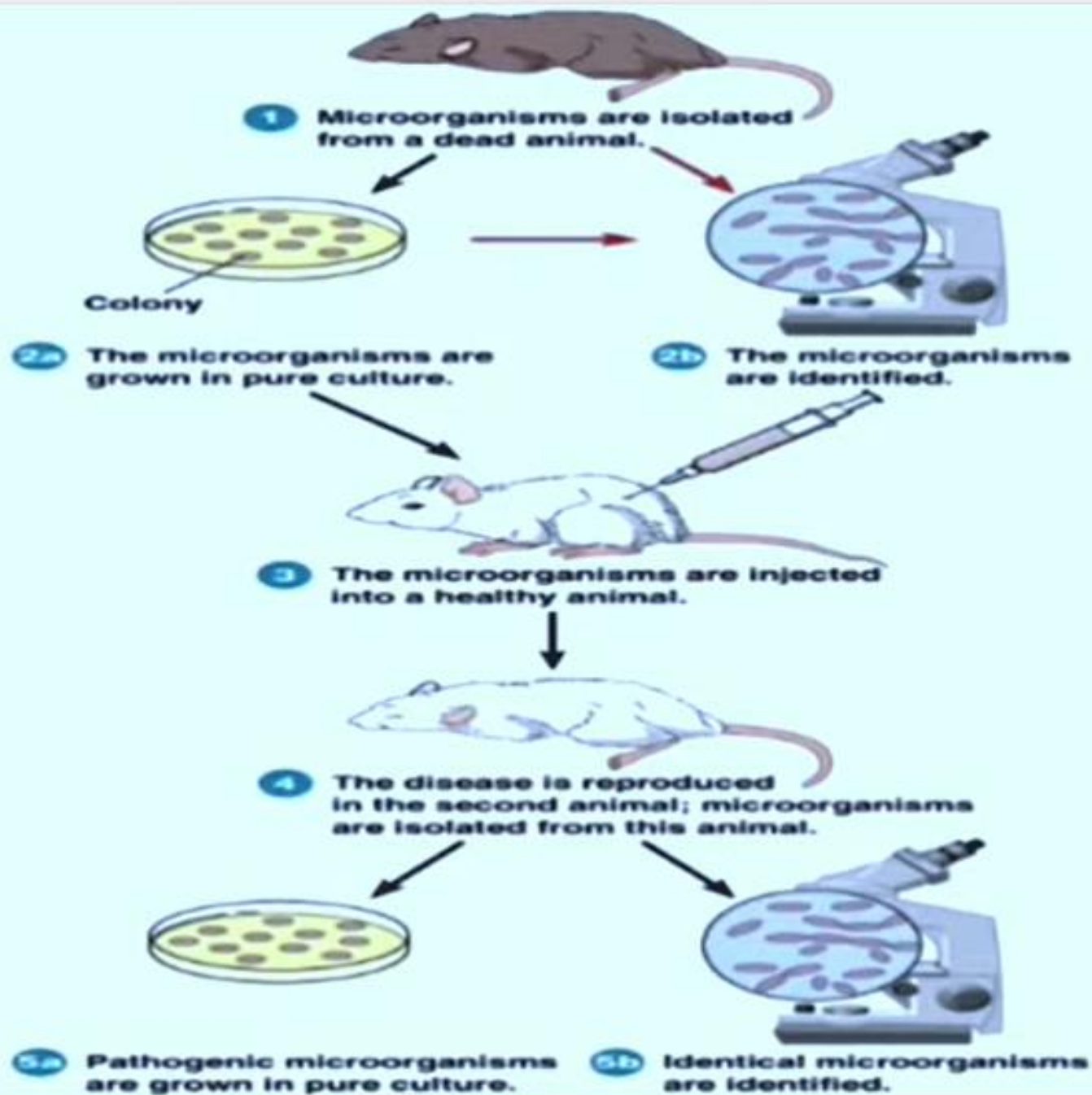
## ***FOUR STEPS OF THE POSTULATES***

Step 1:- The suspected causal organism (bacterium or other microorganism) must be present in every diseased organism (eg.a plant) examined.

Step 2:- The suspected causal agent must be isolated from the diseased host organism (plant) and grown in pure culture.

Step 3:- When the pure culture of the suspected causal agent is inoculated into a healthy susceptible host, the host must reproduce the specific disease.

Step 4:- The same causal agent must be recovered again from the experimentally inoculated and infected host i.e. the recovered agent must have the same characteristics as the organism in step 2.



# Exception to Kochs postulates

- Microorganism that are unable to be cultured on artificial media  
e.g. *Treponema pallidum*
- Two or more organism work in synergy to cause a disease
- Symptoms and diseases can be caused by one of several microbes
- Culture of some viruses, Phytoplasma, fastidious phloem inhabiting bacteria Protozoa and even some obligate parasitic fungi (powdery mildew, downy mildew and rust fungi) is not yet possible.

**THANK YOU**