

Plant Pathology

What is Plant Pathology?

Plant Pathology is the branch of agricultural science that deals with the study of **plant diseases**, their causes, development, effects, and methods of control. It is also called **Phytopathology** (Phyto = plant, Pathos = suffering, Logos = study).



A scientist who studies plant diseases is called a **Plant Pathologist** or **Phytopathologist**.

Plant pathology mainly focuses on:

- Causes of plant diseases
- Disease development and spread
- Interaction between host plant and pathogen
- Prevention and management of diseases

Importance of Plant Pathology

Plant pathology is important because **plant diseases**:

- Reduce crop yield and quality
- Cause economic losses to farmers
- Affect food security
- Reduce market value of crops
- Damage forests, fruits, vegetables, and ornamental plants



Examples:

- Rust disease in wheat
- Late blight of potato
- Citrus canker
- Rice blast disease



Objectives of Plant Pathology

1. To identify plant diseases
2. To study causes of diseases
3. To understand disease development
4. To prevent spread of diseases
5. To develop effective control measures
6. To improve healthy crop production

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Concept of Disease in Plants

Definition of Plant Disease

A plant disease is a harmful deviation from the normal functioning of a plant caused by continuous irritation from pathogens or environmental factors.

According to the concept of plant pathology:

“Disease is a malfunctioning process caused by continuous irritation leading to symptoms.”

A disease affects:

- Growth
- Reproduction
- Photosynthesis
- Nutrient transport
- Overall plant health



Characteristics of Plant Disease

A plant is considered diseased when:



Its normal structure changes



Physiological activities are disturbed



Growth becomes abnormal



Yield decreases



Visible symptoms appear

Causes of Plant Diseases

Plant diseases are mainly divided into two groups:

1. Infectious Diseases (Biotic Diseases)

These are caused by living organisms called pathogens.

Major Plant Pathogens

- Fungi
- Bacteria
- Viruses
- Nematodes
- Phytoplasma
- Protozoa

Examples

- Rust of wheat
- Bacterial blight of rice
- Mosaic disease of tobacco

2. Non-Infectious Diseases (Abiotic Diseases)

These are caused by environmental or nutritional factors.

Causes

- Nutrient deficiency
- Excess moisture
- Drought
- Temperature extremes
- Air pollution
- Toxic chemicals

Examples

- Zinc deficiency in rice
- Sun scorch
- Frost injury

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Fundamentals of Plant Pathology

1. Important Scientists (Plant Pathology)

- ① Anton van Leeuwenhoek
 - First to observe microorganisms (bacteria in dental plaque, 1683)
- ② Robert Koch
 - Developed Koch's Postulates
 - Work on Anthrax disease (etiology)
- ③ E.F. Smith
 - Father of Phytobacteriology
 - Worked on bacterial diseases like crown gall
- ④ Adolf Mayer / Beijerinck
 - Found Tobacco Mosaic Virus (TMV) is a "filterable virus"
- ⑤ Doi et al.
 - Discovered Phytoplasma (Mycoplasma-like organisms)
- ⑥ Iwanowski / Twort & d'Herelle
 - Discovery of bacteriophage

2. Indian Contributions

- ① E.J. Butler
 - Father of Indian Plant Pathology
 - Book : Fungi and Disease in Plants
- ② B.B. Mundkur
 - Founded Indian Phytopathological Society
- ③ K.C. Mehta
 - Father of Indian Rust research
 - Studied cereal rust epidemiology
- ④ J.C. Luthra & Satyawar Singh
 - Solar heat treatment for loose smut of wheat
- ⑤ Hot water treatment
 - Wheat : 52°C for 10 min
 - Sugarcane : 54°C for 30 min
- ⑥ K.R. Kirtikar
 - Early Indian worker in fungi collection



Causes of Plant Disease

1. Inanimate / Abiotic Causes (Disorder)
2. Animate / Biotic Causes (Disease)
- Mesobiotic Causes: Virus —

Plant Pathogen Classification:

★ Biotic → Prokaryotes

- Wall-less: Mycoplasma / Phytoplasma, Spiroplasma
- Walled: Bacteria, Phytobacteria, Blue Green Algae

★ Mesotic → Eukaryotes

- Viruses, Viroids, Virusoids, Prions

Protozoa, Vascular Nematodes, Parasitic Plants, Zooplankton, Nematodes, Dodder, Loranthus

★ Abiotic →

1. Adverse Climate Conditions:
Temp., Light, R.H., Rain, Hail, Frost, Storm
2. Adverse Soil Conditions:
Soil moisture, Texture, Structure, Nutrients, pH
3. Chemical Injuries:
Pollutants, Toxicity of Pesticides
4. Improper Cultural Practices

• Obligative: *Ralstonia fastidiosa* Bacteria

• Facultative: Bacteria, Phytobacteria, Blue Green Algae

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Historical Background of Plant Pathology

Pathos = Suffering / Aliment, Logos = To study about

1. Irish Famine 1845 (Ireland)
 - Late Blight of Potato
 - Pathogen = *Phytophthora infestans*
 2. Coffee Rust 1867 (Sri Lanka)
 - Pathogen = *Hemileia vastatrix*
 3. Downy Mildew of Grapes (France)
 - Pathogen = *Plasmopara viticola*
 4. Bordeaux Mixture 1885
 - Copper Sulphate + Lime + Water (1kg : 1kg : 100 Lit)
 5. Bengal Famine 1943 (Bengal)
 - Crop = Paddy (Rice)
 - Disease = Brown Spot of Rice
 - Pathogen = *Helminthosporium oryzae*
- Directorate of Mushroom Research = Solan, H.P

⇒ Pathogen Types: ⇐

1 Necrotroph
= Kills living cell



2 Biotroph
= Only living cell



3 Facultative Parasite
= Grows on living + dead cell



4 Saprophyte
= Grows on dead cell



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→ Symptoms of Plant Disease ←

- Leaf Spot, Blight, Blotch
- Hyperplasia = Overgrowth of plant tissue
- Hypotrophy = Undergrowth
- Necrosis, Leaf Streak, Anthracnose, Damping off, Canker
- Die-back, Blast, Phyllody - Crop Sesame
- Autecious = Parasite which can complete life cycle in one Host (ex: Wheat)
- Heteroecious (Canthar + Berry) = Parasite complete life cycle in two Host
- God of Rust - *Puccinia* = More species (ex: Rust)
- Mildew, Powdery Mildew, Downy Mildew

* Parasitism *

= Defined relationship between two or more hosts

* Types: *

1. Obligate Parasite
2. Facultative Parasite
3. Ectoparasitism
4. Endoparasitism

* Pathogenesis = Disease Cycle:*

- ①. Inoculation → ②. Penetration → ③. Infection → ④. Invasion →
⑤. Colonization → ⑥. Existence → Disease Cycle

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✧ The Penetration Process in Disease ✧

- Pre-Penetration Process = Attachment of Pathogen
- Post Penetration Process
- * Pre-Penetration Process * = 1. Attachment through air, water
- * Recognition * = _____
- * Penetration Process: *
- *Direct Penetration* = Appre-Soria (Appresoria), Pucina, Pyricularia

Spore

 →

Appresoria

 →

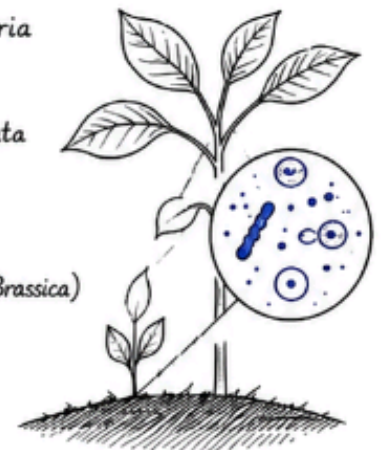
Penetration Peg
- *Indirect Penetration* = Wounds (ex: from operation), Insect, Stomata
 Ex:

Rhizopus, Aspergillus, Penicillium, Colletotrichum

* Penetration through natural openings *

- Stomata - ex: *Puccinia*, *Sphambis*, *Titici*, *Xanthomonas* (White Rust of Brassica)
- Lenticels - ex: *Streptomyces scabies* (Scab disease of Potato)
- Hydathodes - ex: *Xanthomonas campestris Oryzae*

Bacteria enter plants mostly through wounds and less frequently to natural openings



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Viruses, Viroids, Mollicutes, Fastidious Bacteria

★ Direct Penetration:

- Fungi, Nematodes, Parasitic, Higher Plant
 1. Seedling - ex: Ustilago smut of Jowar
 2. Downy Mildew of Jowar and Bajra
 3. Damping off
- **Root Hairs**
ex: Wilt of Chickpea, Club root of Cabbage, Pythium
- **Buds** = ex: 1. Pea Rust, 2. Witches Broom, 3. Phyllody of Sesame
- **Flower** ex: Loose smut of Wheat, Ergot
- **Leaves** ex: 1. Wheat Rust, 2. White Rust of Mustard

Post Penetration =
Infection, Invasion, Colonization

- **Infection** = Parasitic relationship with host
- **Invasion** = Damage
- **Colonization** = Colony start, grow

During invasion, Pathogen produces different substances which include **Enzymes, Toxin, Growth Hormone**

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- Polysaccharide which will help in Colonization in the host

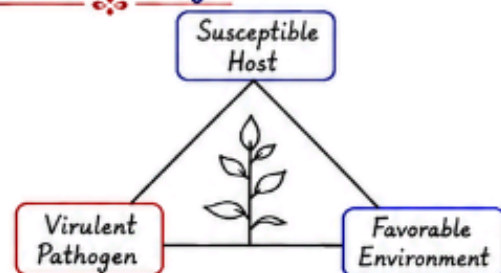
Colonization =

1. **Ectoparasite** = Plant surface growth (Haustoria)
ex: Powdery Mildew (**Pathogen**)
 2. **Endoparasite** = 2 Types:
 - • **Intracellular** = Haustoria go into the cell (**Necrotroph**)
 - • **Intercellular** = Haustoria = grow between cell (**Sclerotinia disease**)
- ex: Fungi, Bacteria, Nematodes

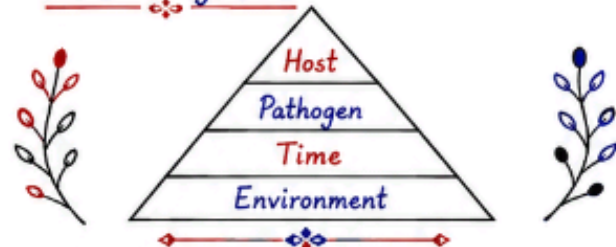
★ **Virus, Viroids, Mycoplasmas** invade tissue by moving from cell to cell intracellularly

4. Development of Disease in Plants

i. Disease Triangle



ii. Disease Pyramid



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Classification of Plant Diseases

↔ = based on Occurrence: ↔

1. **Endemic** = ex: Early Blight of Potato, Tikka Blight
2. **Epidemic** = ex: Red Rot of Sugarcane, Bacterial Blight of Bajra
3. **Sporadic** = ex: Green Ear Disease of Bajra
4. **Pandemic** = Corona 2019

Fungi (Greek word)



- **Mycology** = Study of fungi
- **Mykes** = Mushroom (Fungi),
- Logos** = Study/Knowledge

Characteristics of Fungi:

- Fungi are eukariotic spores, producing (Ascospores), with generally saprophytic (Somatic), presently joints with somatic structure are Filamentous, Branching
- Typically surrounded by cell wall (chitin, Cutin)

Absent: Organelles whose cell wall is composed of Cellulose

Characteristics of Fungi:

- **Distribution** = Cosmopolitan
- **Habitat** = Parasit and Hapasparasitic
- **Nutrition** = Heterotrophs with Absorption
- **Thallus** = Substaneous (having proper basal), Unicellular, Filamentous
- **Cell Wall** = Chitin, upto Fungi, Cellulose
- **Nucleus** = Uninculear, Nucleous

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- **Life** = Simple to Complex
- **Saprophyty** = Sexual and Asexual

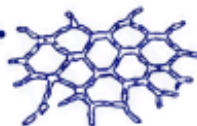
Hyphae

Structure/ unit of fungi = thread - like



Mycelium

A network of hyphae in mass or system



1. Septate mycelium (Incomplete septum)

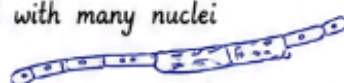
- It is divided up into two or many cells



Ex: Colletotrichum, Alternaria, Agaricus

2. Non Septate mycelium (Delicate septum)

It is one branched with many nuclei



According to situation:

- **Ectophytic mycelium**: When the mycelium can find only on the external surface of host

- Ex: Powdery mildew



- **Endophytic mycelium**: When the mycelium goes into host cell, tissue as endophytic mycelium

- Ex: Ergot

① **Intercellular** = in the cell

② **Intracellular** = in side cell



- **Sclerotium** = A hard resting body, resistance structure, can't germ & from It is unfavourable conditions, which may remain dormant for long period of years & favourable, etc. Arise



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Disease Triangle Concept

The development of disease depends on three important factors:

1. Susceptible Host

A plant capable of getting infected.

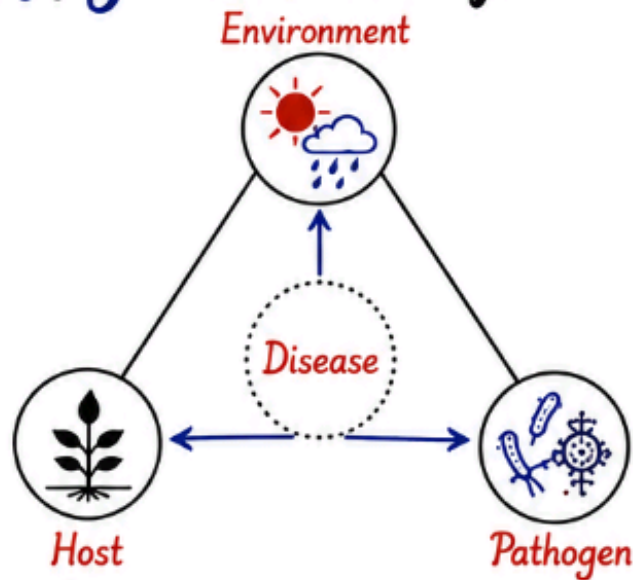
2. Virulent Pathogen

A disease-causing organism capable of attacking the host.

3. Favorable Environment

Suitable temperature, humidity, rainfall, etc., for disease development.

Disease occurs only when all three factors are present together.



Different Terms Used in Plant Pathology

1. Host

The plant that is attacked by a pathogen.
Example: Wheat plant in rust disease.

2. Pathogen

An organism that causes disease.
Example: Fungus causing rust disease.

3. Parasite

An organism that lives on another living organism and obtains food from it.

4. Saprophyte

An organism that obtains food from dead organic matter.

5. Symptom

Visible expression of disease shown by the plant.

Examples:

- Wilting
- Yellowing
- Leaf spots
- Rotting

6. Sign

Actual visible structure of the pathogen on the plant.

Examples:

- Fungal spores
- Mycelium

7. Infection

Entry and establishment of a pathogen inside the host plant.

8. Inoculum

Any part of a pathogen capable of causing infection.

Examples:

- Bacterial cells
- Spores
- Viral particles

9. Incubation Period

Time between infection and appearance of symptoms.

10. Disease Cycle

Sequence of events involved in disease development.

Includes

- Survival
- Spread
- Infection
- Reproduction

11. Epidemic (Epiphytotic)

Rapid spread of disease over a large area.

12. Endemic

Disease constantly present in a particular area.

13. Etiology

Study of causes of plant diseases.

14. Susceptible

A plant that can easily be infected.

15. Resistant

Ability of a plant to prevent disease development.

16. Immunity

Complete freedom from disease attack.

17. Wilt

Loss of rigidity due to lack of water movement.

18. Blight

Rapid drying and death of plant tissues.

19. Rot

Breakdown and decay of plant tissues.

Types

- Soft rot
- Dry rot

20. Canker

Sunken dead area on stem or branches.

21. Chlorosis

Yellowing of green plant tissue due to loss of chlorophyll.

22. Necrosis

Death of plant cells or tissues.

23. Hypertrophy

Increase in size of plant cells.

24. Hyperplasia

Increase in number of plant cells.

25. Vector

An organism that carries pathogens from one plant to another.

Example:

Aphids transmitting viral diseases.

Scope of Plant Pathology

Plant pathology has applications in:

- ✦ Agriculture
- ✦ Horticulture
- ✦ Forestry
- ✦ Seed technology
- ✦ Plant breeding
- ✦ Biotechnology

It helps in:

- ✦ Developing resistant varieties
- ✦ Disease forecasting
- ✦ Biological control
- ✦ Sustainable agriculture

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Thallus*

Note: Fragmentation, fission, budding in plant pathology

1. **Holocarpic*** = Hence the vegetative part as well as reproductive state are same

- The vegetative and reproductive state are same
- Example → Synchytrium endobioticum (Wart disease of Potato)

2. **Eucarpic*** = Most of the fungi is Eucarpic

- Female vegetative
- Vegetative and reproductive
- Example → Puccinia graminis tritici (Rust of Wheat)

Reproduction of Fungi*

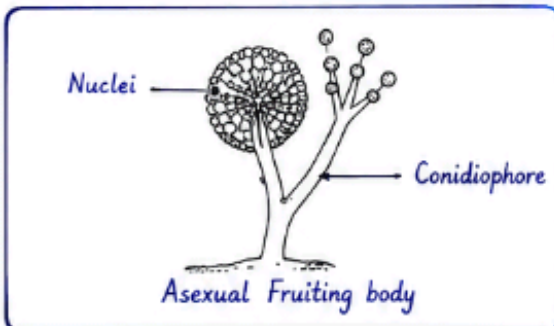
1. Asexual
2. Sexual
3. **Arthrospore*** = Thick wall
4. **Chlamyospore*** = Thick wall

Asexual Spore:* = Fungi (once spore)
Seed - Spore, reproduction unit which separates and new individuals arise on spore in life al.

Spores contain a unicellular or multicellular

1. Conidiospores
2. Conidia or Chlamydia Spores
3. Chlamydia Spore

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1. Pycnidia
2. Conidiospores
3. Chlamydia spores
4. Sporangiospores = Zoospores

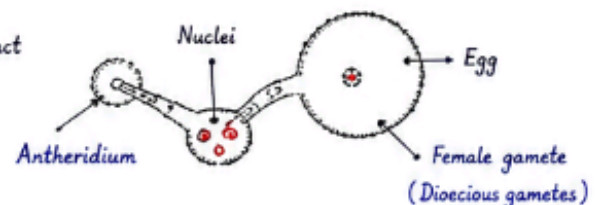
Methods of Sexual reproduction in Fungi*

1. **Plasmogamic Copulation*** = Fusion of two nuclei gametes

- These involves one or several nuclear is nuclei
- In which both Inogamous as well as female gametes are motile and similar in shape and size
- **Karyogami** = Both the gametes are morphologically similar but nuclear fusion takes place in same, hence the nuclei gametes is same nuclei
- **Heterogamous Copulation** = Both gametes are different in shape, size and motility. This results in the formation of Karyogamous Zygote

2. **Gametangial Contact*** = Two and female gamets come in contact (direct touch or pass through)

- Male gamete passes through a pore or tube
- Antheridium, Nuclei, Egg, Primary gamete (Dioecious gametes)



Fusion body in plant pathology

3. **Gametangial Copulation** = It is the process of fusion of either contents of two gametangia

– **Types of fusion :**

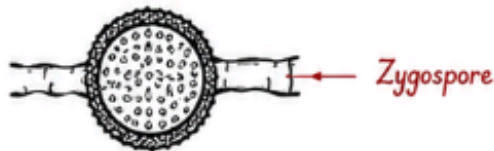
a) **Female gametangia branches** =
Hyphal branches → Zygospore



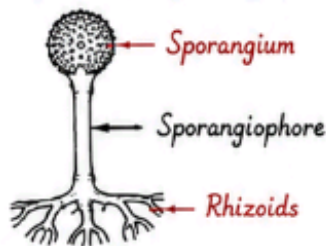
b) **Suspensor** = Zygote → Zygospore



c) [Diagram of Zygospore]



d) [Diagram of Sporangiphore]



e) **Zoospores**



Ex: Aquatic fungi

f) * **Isogamous Copulation** *

Male gametangia, Female gametangia

↓
Naked cell

Ex: Mucor, Rhizopus etc.

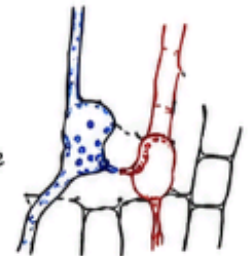
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Spermatization

– **Spermatia**

1. Non-motile
2. Reaches female hyphae

Ex: Rust Fungi



Somatogamy

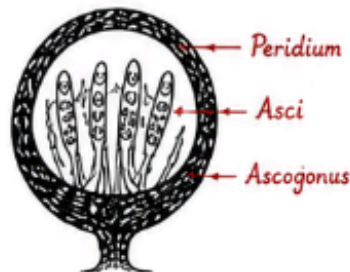
– **Male gamete + Female gamete**



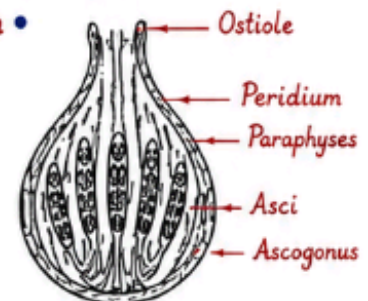
• **Fruiting Body of Sexual Reproduction in Fungi** •

1. • **Chistothecium** •

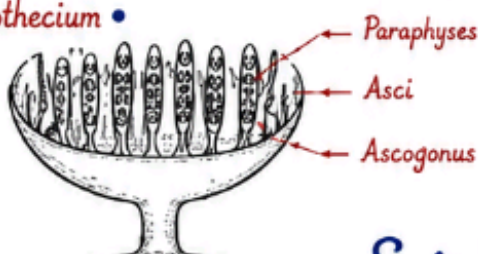
Black in color, shield shaped with a beak, mycelial padding, completely closed, asci and its paraphyses are in gelatinous & structure



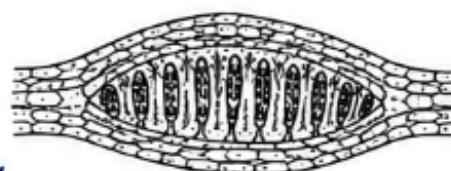
2. • **Perithecium** •



3. • **Apothecium** •



4. • **Pseudothecium or Ascostroma** •



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