DEPARTMENT OF BOTANY
Guru Ghasidas Vishwavidyalaya, Bilaspur
B. Sc. IV Semester
LBC 402: Plant Pathology

SCHEME OF EVALUATION

Time : 3 hours **Maximum Marks : 30**

Section A

Multiple choice questions / Define the following terms **10 × 1 = 10**

1. The 'Irish famine' was due to
   (a) **Late blight of potato** (b) Blast of rice
   (c) Early blight of potato (d) Wart of potato
2. Elicitor molecules are determinants of
   (a) Virulence (b) **Avirulence** (c) Parasitism (d) All
3. Effects of pathogen on photosynthesis
   (a) Toxins may inhibit photosynthesis enzyme
   (b) Decrease in chlorophyll contents or chlorosis
   (c) Closed stomata
   (d) **All the above**
4. 'Harting nets' are found in
   (a) **Ectomycorrhiza** (b) Endomycorrhiza
   (c) Oomycetous fungi (d) Ascomycetous fungi
5. Black rust of wheat is caused by
   (a) ***Puccinia graminis*** (b) *Puccinia recondita*
   (c) *Puccinia striformis* (d) *Puccinia glumarum*

6. **Mistletoe :** Mistletoe is the common name for obligate hemi-parasitic plants in several families in the order Santalales. These plants grow attached to and penetrating within the branches of a tree or shrub by a structure called the haustorium, through which they absorb nutrients from the host plant.
7. **Parasitism :** Parasitism is a non-mutual relationship between organisms of different species where one organism, the parasite, benefits at the expense of the other, the host.
8. **Epidemic or Epiphytotic disease :** A disease usually occurs widely but periodically in a destructive form is referred as epidemic or Epiphytotic disease. Example: Late blight of potato – Irish famine (1845)
9. **Inoculum potential :** The resultant of the action of environment, the vigour of the pathogen to establish an infection, the susceptibility of the host and the amount of inoculum present.
10. **Systemic infection :** The growth of pathogen from the point of entry to varying extents without showing adverse effect on tissues through which it passes.

Section B

Descriptive answer type questions (attempt any four) **4 × 5 = 20**

1. Write brief notes on :

(i) Views of Theophrastus about plant diseases.

- The climate and soil of countries around the eastern Mediterranean Sea, from where many of the first records of antiquity came to us, allow the growth and cultivation of many plants.
- The most important crop plants for the survival of people and domesticated animals were seed-producing cereals, especially wheat, barley, rye, and oats and legumes, especially beans, fava beans, chickpeas and lentils.
- Fruit trees such as apple, citrus, olives, peaches and figs as well as grapes, melons, and squash were also cultivated. All of these crop plants suffered losses annually due to drought, insects, diseases and weeds.
- Because most families grew their own crops and depended on their produce for survival until the next crop was produced the following year.
- The contributions of Theophrastus to knowledge about plant disease are quite limited and influenced by the beliefs of his times.
- He observed that plant diseases were much more common and severe in lowlands than on hillsides and that some diseases i.e. rusts, were much more common and severe on cereals than on legumes.
- According to Theophrastus plant diseases were a manifestation of the wrath of God and therefore, that avoidance or control of the disease depend on people doing things that would please that same superpower.

(ii) Distinguish between penetration and infection with suitable diagrams.

Answer :

- Infection process means establishment of pathogen in the host plant. Entry and colonization of pathogen in the host tissues is known as establishment and the infective propagules coming in contact with the host are known as **inoculum**.
- It is defined as the energy of growth of a parasite available for infection of a host at the surface of the host organ to be infected .
- The success of process of infection depends on

  1. **Host factors**

  Susceptibility of host: It is genetically controlled by DNA and it is an inheritable character which is transmitted from parents to off springs.

  Disease proneness of the host: It is decided by the external factors such as host nutrition, i.e., more nitrogen application makes the host more susceptible and more potash application leads to less susceptibility.

  2. **Pathogen factors**

  Virulence / aggressiveness of the pathogen: It is determined by genetic material which is inheritable.

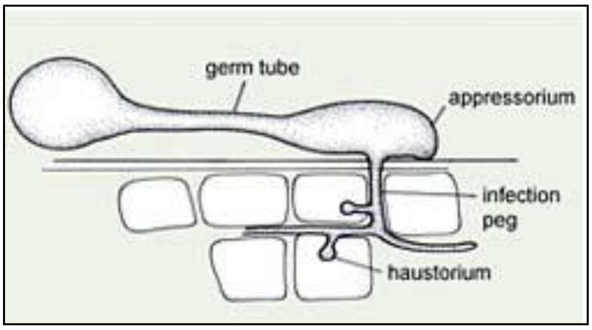
  High multiplication rate of the pathogen: Chances of infection increases with high rate of multiplication. High birth rate and low death rate is highly essential for successful infection.

  Proper inoculum potential: In case of specialized pathogens very few or even one spore is capable of causing infection successfully, whereas, non-specialized pathogens require high density of inoculum on the surface of susceptible host for successful infection.

Environmental factors: Environmental conditions such as temperature, relative humidity, moisture, etc., are very important for survival, dissemination and infection process.

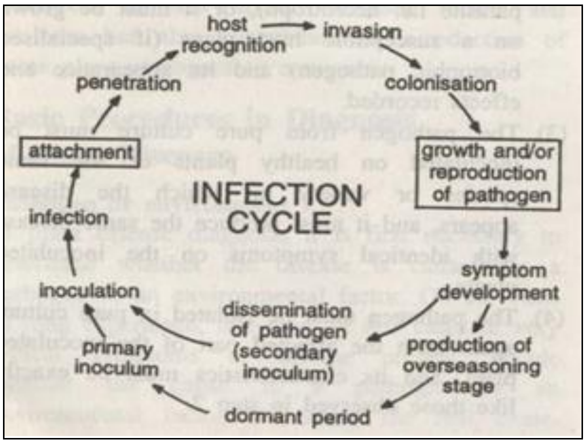
- Process of infection can be grouped into three stages, *i.e.*, pre-penetration, penetration and post-penetration.
- **PRE-PENETRATION :** Plant viruses are particulate in nature and they do not have any capacity to enter the host cell so they do not make any aggressive effort for entry, but depend on different insect vectors for their entry into host cell. Bacteria have no dormant structures; hence no prepenetration activity except for multiplication in infection drops on the natural openings. However, nematodes show some orientation towards root surface before actual penetration.

Rhizomorphs



Appressorium

- **PENETRATION:** Pathogens penetrate plant surfaces by direct penetration or indirectly through wounds or natural openings. Bacteria enter plants mostly through wounds and less frequently through natural openings. Viruses, viroids, mollicutes, fastidious bacteria enter through wounds made by vectors. Fungi, nematodes and parasitic higher plants enter through direct penetration and less frequently through natural openings and wounds.
- **POST PENETRATION : Invasion and colonization:** Infection is the process by which pathogens establish contact with the susceptible cells or tissues of the host and derive nutrients from them. A parasitic relationship is formed between host cytoplasm and parasite cytoplasm. During infection, pathogens grow and multiply within the plant tissues. **Invasion** of plant tissues by the pathogen, and growth and reproduction of the pathogen (**colonization**) are two concurrent stages of disease development.



Stages in the development of infection or disease cycle

2. What is pathogenicity? Describe different stages in the development of plant diseases.

Answer :

- **Pathogenicity**: the ability of a pathogen to cause disease, as the ability of the parasite to invade and become established in the host generally results in the development of a diseased condition in the host.
- In some cases of parasitism, as with the root nodule bacteria of legume plants and the mycorrhizal infection of feeder roots of most flowering plants, both the plant and the microorganism benefit from the association. This phenomenon is known as **symbiosis**.
- **Pathogenicity**: is the ability of the parasite to interfere with one or more of the essential functions of the plant, thereby causing disease.
- **Host range of pathogens :** Pathogens differ with respect to the kinds of plants that they can attack, with respect to the organs and tissues that they can infect, and with respect to the age of the organ or tissue of the plant on which they can grow.
- **The disease Triangle :** At least two components (plant and pathogen) must come in contact and must interact. If at the time of contact of a pathogen with a plant, and for some time afterward, conditions are too cold, too hot, too dry, or some other extreme, the pathogen may be unable to attack or the plant may be able to resist the attack, and therefore, despite the two being in contact, no disease develops. Each of the three components can display considerable variability; however, as one component changes it affects the degree of disease severity within an individual plant and within a plant population.

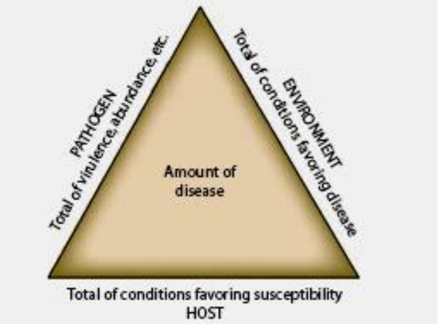
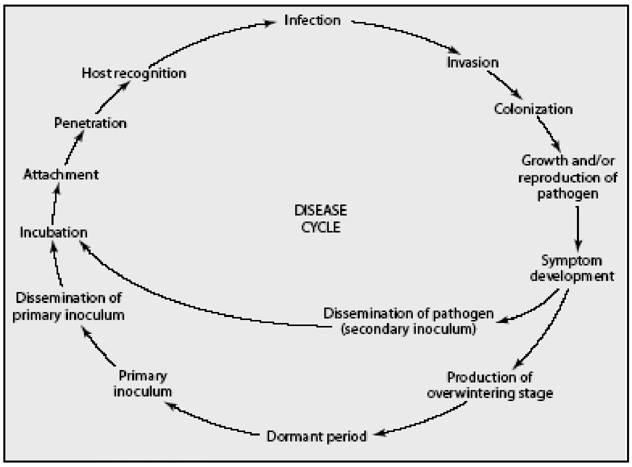


FIGURE 2-1 The disease triangle.

- **The disease cycle :** In every infectious disease a series of more or less distinct events occurs in succession and leads to the development and perpetuation of the disease and the pathogen. This chain of events is called a disease cycle. A disease cycle sometimes corresponds fairly closely to the life cycle of the pathogen, but The events in a disease cycle are: Inoculation, penetration, establishment of infection, colonization (invasion), growth and reproduction of the pathogen, dissemination of the pathogen, and survival of the pathogen in the absence of the host, i.e., overwintering or oversummering, overseasoning) of the pathogen.

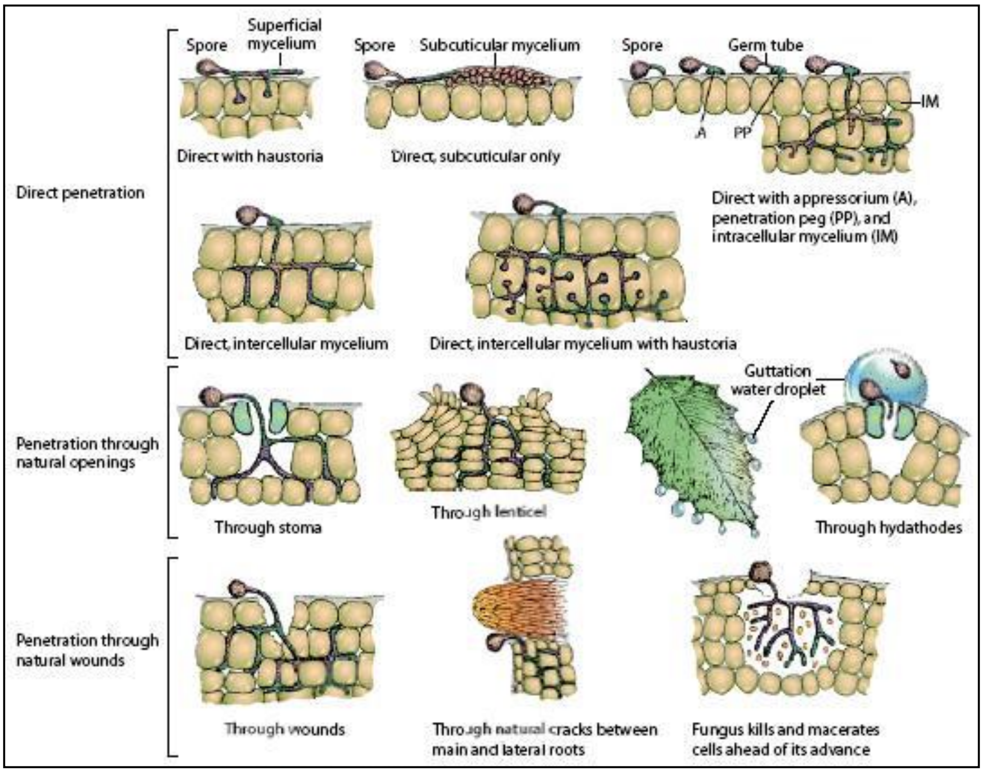


- **Inoculation : Inoculation** is the initial contact of a pathogen with a site of plant where infection is possible. The pathogen(s) that lands on or is otherwise brought into contact with the plant is called the **inoculum**. The inoculum is any part of the pathogen that can initiate infection. Thus, in fungi the inoculum may be spores,**sclerotia** (i.e., a compact mass of mycelium), or fragments of mycelium. In bacteria, mollicutes, protozoa, viruses, and viroids, the inoculum is always whole individuals In nematodes, the inoculum may be adult nematodes, nematode juveniles, or eggs. In parasitic higher plants, the inoculum may be plant fragments or seeds. One unit of inoculum of any pathogen is called a **propagule**.

- **Types of Inoculum :** An inoculum that survives dormant in the winter or summer and causes the original infections in the spring or in the autumn is called a **primary inoculum**, and the infections it causes are called **primary infections**. An inoculum produced from primary infections is called a **secondary inoculum** and it, in turn, causes **secondary infections**.
- **Sources of Inoculum :** In some fungal and bacterial diseases of perennial plants, such as shrubs and trees, the inoculum is produced on the branches, trunks, or roots of the plants. The inoculum sometimes is present right in the plant debris or soil in the field where the crop is grown; other times it comes into the field with the seed, transplants, tubers, or other propagative organs or it may come from sources outside the field. Outside sources of inoculums may be nearby plants or fields or fields many miles away. In many plant diseases, especially those of annual crops, the inoculum survives in perennial weeds or alternate hosts, and every season it is carried from them to the annual and other plants.
- **Landing or Arrival of Inoculum :** The inoculum of most pathogens is carried to host plants passively by wind, water, and insects i.e. **Airborne and Soil born inoculums**

Prepenetration Phenomena: Attachment of Pathogen to Host

- Pathogens such as mollicutes, fastidious bacteria, protozoa, and most viruses are placed directly into cells of plants by their vectors and, in most cases, they are probably immediately surrounded by cytoplasm, cytoplasmic membranes, and cell walls. Attachment takes place through the adhesion of spores, bacteria, and seeds through adhesive materials that vary significantly in composition and in the environmental factors they need to become adhesive.
- **Spore Germination and Perception of the Host Surface :** It is not clear what exactly triggers spore germination, but stimulation by the contact with the host surface, hydration and absorption of low molecular weight ionic material from the host surface, and availability of nutrients play a role. Spores also have mechanisms that prevent their germination until they sense such stimulations or when there are too many spores in their vicinity.
- **Germination of Spores and Seeds :** Almost all pathogens in their vegetative state are capable of initiating infection immediately. Fungal spores and seeds of parasitic higher plants, however, must first germinate. Spores germinate by producing a typical mycelium that infects and grows into host plants or they produce a short germ tube that produces a specialized infectious structure, the **haustorium**. In order to germinate, spores require a favourable temperature and also moisture in the form of rain, dew, or a film of water on the plant surface or at least high relative humidity.



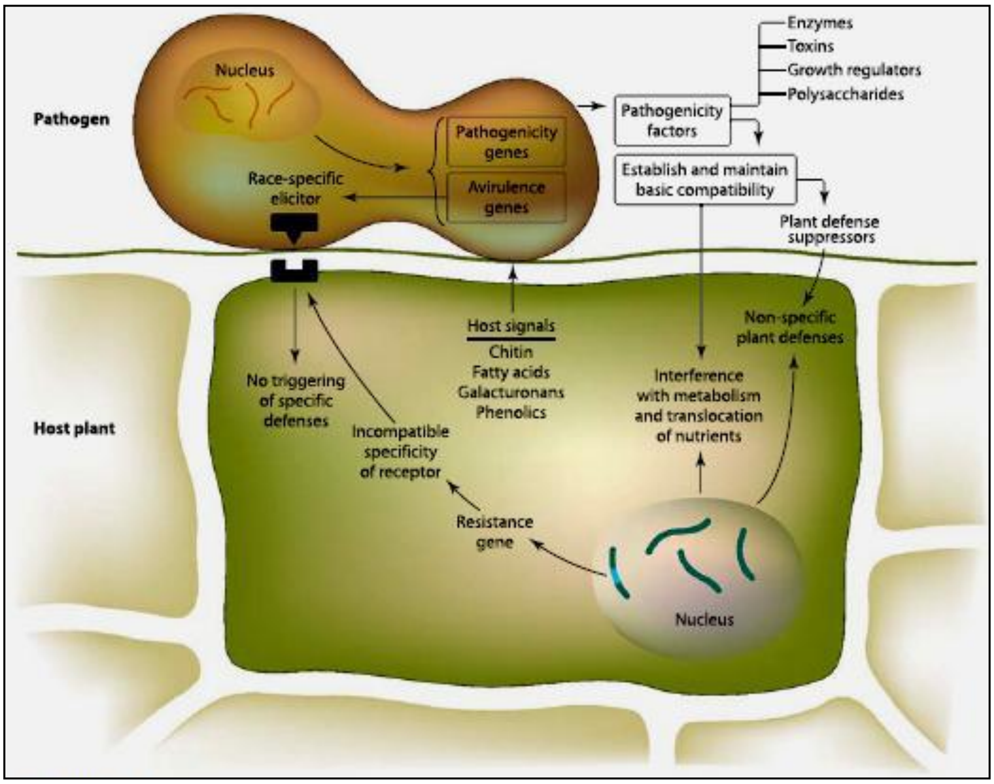


***Fig :** Establishment of infection in a compatible reaction between a pathogen and its host plant*

- **Penetration :** Pathogens penetrate plant surfaces by direct penetration of cell walls, through natural openings, or through wounds. Some fungi penetrate tissues in only one of these ways, others in more than one. Bacteria enter plants mostly through wounds, less frequently through natural openings, and never directly through unbroken cell walls. Penetration does not always lead to infection .
- **Direct Penetration through Intact Plant Surfaces :** Direct penetration through intact plant surfaces is probably the most common type of penetration by fungi, oomycetes, and nematodes and the only type of penetration by parasitic higher plants. None of the other pathogens can enter plants by direct penetration.
- **Penetration through Natural Openings :** Many fungi and bacteria enter plants through stomata, and some enter through hydathodes, nectarthodes, and Lenticels. Stomata are most numerous on the lower side of leaves. Bacteria present in a film of water over a stoma and, if water soaking occurs, can swim through the stoma easily and into the substomatal cavity where they can multiply and start infection. Fungal spores generally germinate on the plant surface, and the germ tube may then grow through the stoma.
- **Hydathodes** are more or less permanently open pores at the margins and tips of leaves; they are connected to the veins and secrete droplets of liquid, called guttation drops, containing various nutrients. Some bacteria use these pores as a means of entry into leaves, but few fungi seem to enter plants through hydathodes. Some bacteria also enter blossoms through the nectarthodes or nectaries.
- **Lenticels** are openings on fruits, stems, and tubers that are filled with loosely connected cells that allow the passage of air. During the growing season, lenticels are open, but even so, relatively few fungi and bacteria penetrate tissues through them.

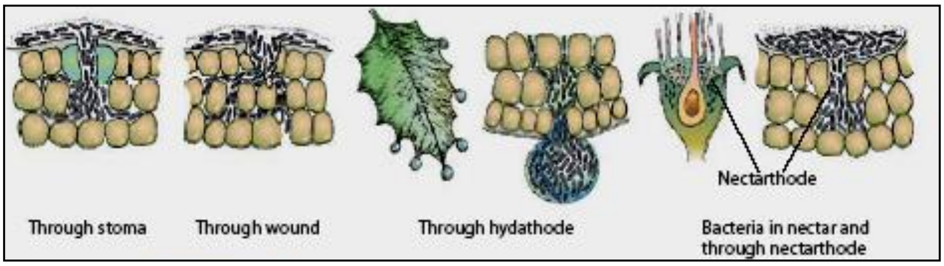


Fig : Methods of penetration and invasaion

- **Infection : Infection** is the process by which pathogens establish contact with susceptible cells or tissues of the host and procure nutrients from them. Following infection, pathogens grow, multiply, or both within the plant tissues and invade and colonize the plant to a lesser or greater extent. Successful infections result in the appearance of symptoms.
- The time interval between inoculation and the appearance of disease symptoms is called the **incubation period**. The length of the incubation period of various diseases varies with the particular pathogen–host combination, with the stage of development of the host, and with the temperature in the environment of the infected plant.
- **Infection requirements:** 1-The plant variety must be susceptible to the particular pathogen and at a susceptible stage. 2-The pathogen must be in a pathogenic stage that can infect immediately without requiring a resting (dormancy) period first, or infective juvenile stages or adults of nematodes. 3-The temperature and moisture conditions in the environment of the plant must favour the growth and multiplication of the pathogen.
- **Invasion :** Various pathogens invade hosts in different ways and to different extents. Some fungi, such as those causing apple scab and black spot of rose, produce mycelium that grows only in the area between the cuticle and the epidermis (subcuticular colonization); others, such as those causing powdery mildews, produce mycelium only on the surface of the plant but send haustoria into the epidermal cells. 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**. Viruses, viroids, mollicutes, fastidious bacteria, and protozoa invade tissues by moving from cell to cell intracellularly. Other infections enlarge more or less rapidly and may involve an entire plant organ (flower, fruit, leaf), a large part of the plant (a branch), or the entire plant. Infections caused by fastidious xylem-or phloeminhabiting bacteria, mollicutes, and protozoa and natural infections caused by viruses and viroids are **systemic**, i.e., the pathogen, from one initial point in a plant, spreads and invades most or all susceptible cells and tissues throughout the plant.
- **Growth and Reproduction of the Pathogen (Colonization) :** Individual fungi and parasitic higher plants generally invade and infect tissues by growing on or into them from one initial point of inoculation. Most of these pathogens, whether inducing a small lesion, a large infected area, or a general necrosis of the plant, continue to grow and branch out within the infected host indefinitely so that the same pathogen individual spreads into more and more plant tissues until the spread of the infection is stopped or the plant is dead.
- **Dissemination of the Pathogen :** A few pathogens, such as nematodes, oomycetes, zoosporic fungi, and bacteria, can move short distances on their own 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 centimeters.
- Dissemination by air, water, insects, mites, nematodes, other vectors, pollen, seed, transplants, budwood, nursery stock and humans.

3. Write an essay on the effect of pathogens on translocation of water and nutrients in the host plant.

Answer :

- All living plant cells require an abundance of water and adequate amount of organic and inorganic nutrients in order to live and to carry our their physiological functions. Plant absorb the water and inorganic nutrients form the soil through their root system.
- **Xylem**
  - Water and Minerals Absorbed by Roots
  - Translocated through the Xylem Vessels of the Stem
  - Into Vascular Bundles of Petioles and Leaf Veins
  - Enter the Leaf Cells
  - Water and Minerals Absorbed by Roots
  - Translocated through the Xylem Vessels of the Stem
  - Into Vascular Bundles of Petioles and Leaf Veins
  - Enter the Leaf Cells
- Pathogens Interfere with Normal Translocation Process
  - Flow of Nutrients or Water Blocked
  - Disease in Affected Cells/Tissues
  - Inability to Carry Out Functions
  - Shortage of their Products
  - Disease in Entire Plant
- How Can Pathogens Impair Translocation of Water and Inorganic Nutrients?
  - **Root damage** –Damping off fungi
  - **Root rot** –fungi, bacteria,–most nematodes –some viruses
  - **Mechanisms of damage** –cause direct injury to roots, –inhibit root hair production and –alter permeability of root cells.
  - **Xylem gets destroyed** : rot or canker pathogens –gall formation
  - **Xylem gets clogged :** –growth of vascular wilt pathogens, –pathogen secretions, –secretions of tylose by plant in response to the pathogen.
  - **Excessive transpiration occurs when pathogens damage leaves, stomata :** leaf cuticle protects against excessive water loss, –rusts, mildews and apple scab destroy considerable portion of cuticle and epidermis, –loss of turgor and wilting of leaves, –suction forces may lead to collapse or dysfunction of underlying vessels
- **Phloem**
  - Carbohydrates produced in leaf cells move through plasmodesmata into adjoining phloem elements
  - Move down phloem sieve tubes
  - Move into nonphotosynthetic cells or into storage organs
  - Nutrients are removed from ‘circulation’
  - **How can pathogens impair translocation in the phloem?**
  - Movement of substances from leaf cells to the phloem
  - Translocation through phloem elements
  - Movement from phloem into cells that will use the nutrients

- **Obligate fungal parasites (eg: rust and mildew) :** Respiration increases, –P/S decreases, however, photosynthetic products accumulate in invaded areas, apparently nutrients from uninfected areas are translocated toward the infected areas.
- **Viruses** : Viruses that cause leaf-curling and some yellows diseases cause death of phloem, – some viruses inhibit enzymes that break down starch into smaller, translocatable molecules.

4. Explain the followings :

(i) Koch's Postulates

Answer :

- Koch's postulates are four criteria designed to establish a causal relationship between a causative microbe and a disease. The postulates were formulated by Robert Koch and Friedrich Loeffler in 1884 and refined and published by Koch in 1890.

  Koch's postulates are the following:

  a. The microorganism must be found in abundance in all organisms suffering from the disease, but should not be found in healthy organisms.
  b. The microorganism must be isolated from a diseased organism and grown in pure culture.
  c. The cultured microorganism should cause disease when introduced into a healthy organism.
  d. The microorganism must be reisolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent.

(ii) Cultural methods of plant disease control

Answer :

- **Cultural disease management** practices are the measures undertaken by humans to prevent and control disease by manipulating plants. In the case of low-return crops, these might be the only forms of disease management that are economically viable. Cultural management can include reducing the amount of initial inoculum, reducing the rate of spread of an established disease, or planting a crop at a site that is not favourable to pathogens because of its altitude, temperature, or water availability.
- Cultural methods for disease control refer to those growing methods that reduce pathogen levels or reduce the rate of disease development.

  REDUCING THE LEVELS OF INOCULUM

- Practices that reduce the initial levels of inoculum include selecting appropriate planting materials, destruction of crop residues, elimination of living plants that carry pathogens, and crop rotation. The **selection of appropriate planting material** can involve planting resistant cultivars, planting a number of mixed cultivars, using certified seed and ensuring that disease is not spread on vegetative propagating material or on equipment. Many agricultural systems are characterized by dense populations with genetic homogeneity (monocultures). Once a disease becomes established in such a plant community, it can rapidly spread to epidemic proportions. Hence the value of planting mixed cultivars, which incorporate a range of resistances..
- The **destruction of crop residues**, which can harbor many pathogens, by burying, burning or removal is an important practice performed between cropping seasons. How this is done depends on the type of crop, the type of pathogen and the size of the crop.

- **Burying crop residues** can destroy some pathogens, if ploughed in deeply enough, but some pathogens can survive, and even benefit from this process if it serves to spread them throughout the field.
- **Burning crop debris** is a common practice, especially for cereal crops, and it is a successful method of destroying many pathogens. Its success depends on the intensity of the fire. There are disadvantages to burning also, such as loss of nutrients, smoke pollutions, increased soil erosion and contributing to the greenhouse effect.
- The **elimination of living plants that carry pathogens** can include both remnant or diseased crop plants and also wild plants or weeds that can act as alternative hosts between seasons. Some rusts, for example, cannot complete their life cycle in the absence of an alternate host, where they undergo sexual recombination.
- **Crop rotation** refers to the successive planting of different crops in the same area, sometimes with a fallow, or resting, period in between crops.

REDUCING THE RATE OF SPREAD OF DISEASE

- **Tillage practices** have indirect effects on the spread of plant pathogens, although, some forms of inoculum can be spread extensively during tillage.
- **Sowing practices,** such as changing time, depth and direction of sowing, and changing the density of the crop can protect plants from pathogens to which they are susceptible only at certain stages of their development. Changing the time of sowing can exploit weather conditions that are unfavourable to the pathogen, thus reducing crop losses.
- **Crop density** and disease incidence are usually correlated, mainly due to the ease with which inoculum is transferred between plants when they are close together and their leaves and roots are able to touch.
- **INTERCROPPING** : The practice of planting more than one crop in alternating rows, or intercropping, can reduce disease by increasing the distance between plants of the same species, and creating a physical barrier between plants of the same species. Intercropping is more labor intensive the more crops there are, but it is usually beneficial.
- **FLOODING :** Flooding can be used as a form of disease management, as in the example of growing rice in paddy fields. Its primary purpose is to reduce weeds, but it can also reduce the number of fungal propagules, insects and nematodes in the soil.
- **ROGUING :** The removal and destruction of diseased plants, or rogues, can prevent further spread of disease, but is labour intensive.
- **FERTILISERS AND CROP NUTRITION** : A well-balanced supply of soil nutrients will result in healthy, vigorous plants, which should have a greater chance of withstanding attack by pathogens that unhealthy plants would. However, many pathogens also thrive under ideal growth conditions, particularly biotrophic pathogens, such as viruses. The major nutrients that influence plant and pathogen success are nitrogen, phosphorous, potassium and calcium.

5. What are the different chemical fungicides for plant disease control?

Answer :

- Use of chemicals for the control of plant diseases is generally referred to as protection or therapy.
- Fungicides are classified into three categories:
    a. ***Protectants:*** These are the chemicals which are effective only when used before infection (prophylactic in behavior). Contact fungicides which kill the pathogen present on the host

surface when it comes in contact with the host are called protectants. These are applied to seeds, plant surfaces or soil. These are non-systemic in action i.e. Zineb,sulphur, captan, Thiram, etc.

b. ***Eradicants***: Those chemicals which eradicate the dormant or active pathogen from the host. They can remain on/in the host for some time i.e. Lime sulphur, Dodine.

c. ***Therapeutants*****:** These are the agents that inhibit the development of a disease syndrome in a plant when applied after infection by a pathogen. Therapy can be by physical means (solar and hot water treatment) and chemical means (by use of systemic fungicides, i.e., chemotherapy).

CLASSIFICATION OF FUNGICIDES BASED ON CHEMICAL NATURE

a. ***Copper Fungicides :*** Bordeaux mixture, Bordeaux paste, Burgundy mixture, Cheshunt compound, Copper oxy chloride, Cuprous oxide, Copper hydroxide.

b. ***Sulphur Fungicides :*** Sulphur is probably the oldest chemical used in plant disease management for the control of powdery mildews and can be classified as inorganic sulphur and organic sulphur. Inorganic sulphur fungicides include lime sulphur and elemental sulphur fungicides. Organic sulphur fungicides, also called as carbamate fungicides, are the derivatives of dithiocarbamic acid i.e. Lime sulphur, Sulphur dust, Wettable sulphur, Ziram, Ferbam, Thiram, Nabam, Zineb, Maneb.

c. ***Hetrocyclic Nitrogenous Compounds*** **:** The group of heterogeneous fungicides includes some of the best fungicides like captan, folpet, captafol, vinclozoline and Iprodione. Captan, folpet and captafol belong to dicarboximides and are known as pthalamide fungicides. The new members of dicarboximide group are Iprodione, vinclozolin, etc.

SYSTEMIC FUNGICIDES

- The systemic fungicides were first introduced by Von Schelming and Marshall Kulka in 1966. The discovery of Oxathiin fungicides was soon followed by confirmation of systemic activity of pyrimidines and benzimidazoles. A systemic fungicide is capable of managing a pathogen remote from the point of application. Examples : Metalaxyl, Benalaxyl, Chloroneb, Carbendazim, Benomyl, Thiabendazole, Carboxin, Oxycarboxin, Fanapanil, Iprobenphos, Fenarimol, Thiophanate methyl, Tricyclazole, Kresoxim methyl etc.

CLASSIFICATION OF FUNGICIDES BASED ON METHOD OF APPLICATION

- The fungicides can also be classified based on the nature of their use in managing the diseases.

a. ***Seed protectants:*** Ex. Captan, thiram, carbendazim, carboxin etc.

b. ***Soil fungicides*** (preplant): Ex. Bordeaux mixture, copper oxy chloride, Chloropicrin, Formaldehyde, Vapam, etc.

c. ***Soil fungicides***: Ex. Bordeaux mixture, copper oxy chloride, Captan, PCNB, thiram etc.

d. ***Foliage and blossom***: Ex. Capton, ferbam, zineb, mancozeb, chlorothalonil etc.

e. ***Fruit protectants***: Eg. Captan, maneb, carbendazim, mancozeb etc.

f. ***Eradicants***: EX. Lime sulphur

g. ***Tree wound dressers***: Ex. Boreaux paste, chaubattia paste, etc.

h. General purpose sprays and dust formulations.

6. Differentiate between rust and smut diseases. Give causal organisms, different stages of sporulation and their control measures.

Answer :

RUST DISEASES

- Stripe rust, leaf rust and stem rust are three historically important wheat diseases that occur in Arkansas. In severe epidemics, all three rust diseases can significantly reduce yield. Stripe rust is currently the most severe rust disease.

CAUSE

- Wheat rusts are caused by three related fungi:
  - Stripe rust is caused by *Puccinia striiformis* f. sp. *tritici*.
  - Leaf rust is caused by *Puccinia triticina*.
  - Stem rust is caused by *Puccinia graminis* f. sp. *tritici*.

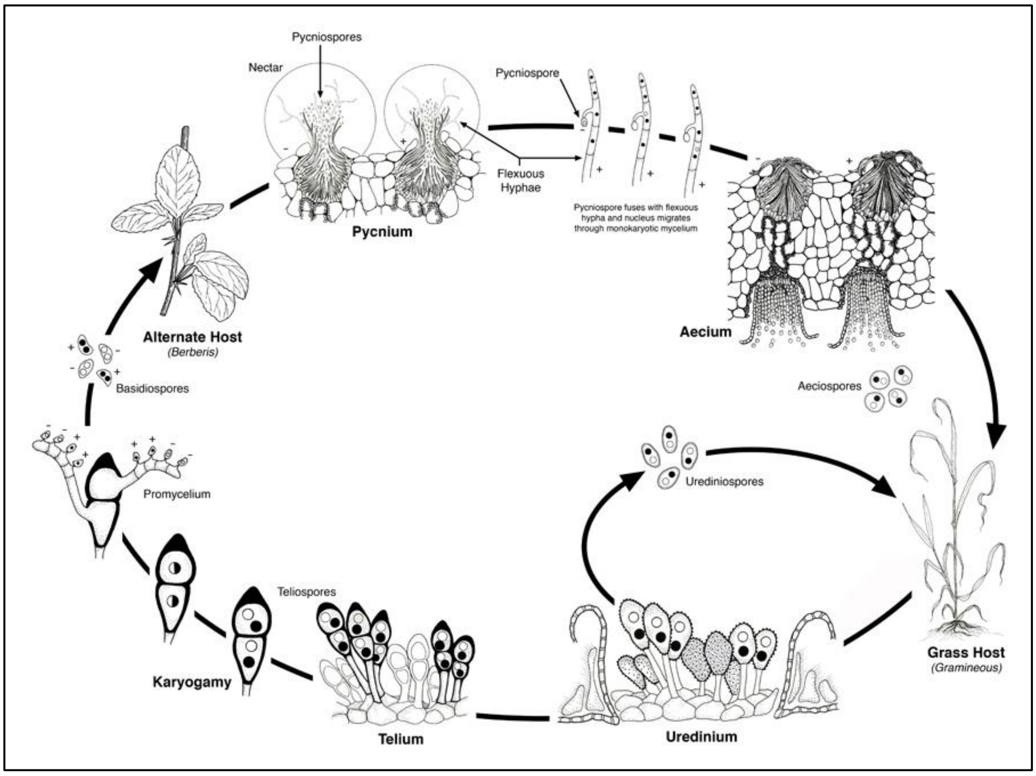
SYMPTOMS

- Stripe rust is called yellow rust in most parts of the world. It can be distinguished from other rusts by the dusty yellow urediniospores produced in lesions that grow systemically in leaves. Symptoms from overwintering infections occur on leaves closest to the ground and tend to cover the entire width of leaves rather than being in stripes. Infection spreads to nearby plants and creates distinct ‘hot-spots’ that can be seen from a distance by heading time. Symptoms on upper leaves are restricted by leaf veins and develop into the characteristic long, slender stripes from which stripe rust gets its name.
- Depending on variety, heads may become infected and yellow spores can be produced on the tissue surrounding the seed. Near crop maturity, black pustules (telia) that do not open form in stripes on both sides of the leaves.
- Teliospores produced in these pustules do not cause disease on wheat and will likely not be seen.
- Leaf rust attacks only leaves and can be distinguished by the dusty, reddish-orange to reddish-brown urediniospores produced in oval pustules on the upper surface of leaves. Pustules are small (up to 1/16 inch or 1.5 mm long) and, unlike stripe rust, do not form in stripes. Several to many pustules can be found on a leaf. Leaf rust can be found from fall through crop maturity, but it is most common in April and May. Black pustules (telia) may be produced in leaf rust lesions late in the season, but their spores (teliospores) do not cause disease on wheat.
- Stem rust attacks both leaves and stems. On leaves, pustules are oval to diamond-shaped and much larger (up to 3/8 inch long) than those produced by leaf rust. Unlike leaf rust, stem rust pustules produce spores on both sides of the leaf. Pustules on the stem are elongated vertically and have jagged pieces of torn epidermis along the sides. Dusty, reddish-brown spores are produced on both leaves and stems. If stem rust occurs in Arkansas, it typically won’t develop until after flowering.

CONTROL

- **Resistance :** Planting resistant varieties is the best way to control wheat rusts. Resistant varieties significantly reduce both infection and spore production, which reduces spread to surrounding fields. Because stripe rust has been the most significant rust disease since 2000, it is very important to choose a variety with resistance to stripe rust.
- **Chemical :** Chemical control is more effective when rust diseases are identified on susceptible varieties early in the growing season. In fields planted with moderately resistant or resistant varieties, a fungicide application may not be necessary even if some disease occurs.

- Crop rotations and modified tillage practices are not effective against rusts. Triazole seed treatments suppress fall rust infections.



SMUT DISEASE

SYMPTOMS

- Infected wheat plants often, but not always, tend to be slightly shorter than healthy plants. After heading, the spikelets of infected plants tend to "flare-out" and take on a greasy, off-green color. This "flaring out" of the spikelet is due to the expansion in size of the bunt infected seed that has become filled with teliospores. In cultivars that normally produce long awns (bristle-like structures), infected heads may have shorter awns, or even no awns. In place of normal seeds, infected kernels develop into "bunt balls" . These are the remnants of what would normally be a seed, but in its place, the seed coat remains intact with the inside converted into a black mass of spores. The name "smut," which is derived from the Germanic word for "dirty," comes from this black spore stage. The name "bunt" comes from a dialectic contraction of the term "burnt ears" to "bunt ear" and finally to just "bunt."

CAUSE

- Smut of wheat is caused by *Tilletia tritici* and *T. laevis*.

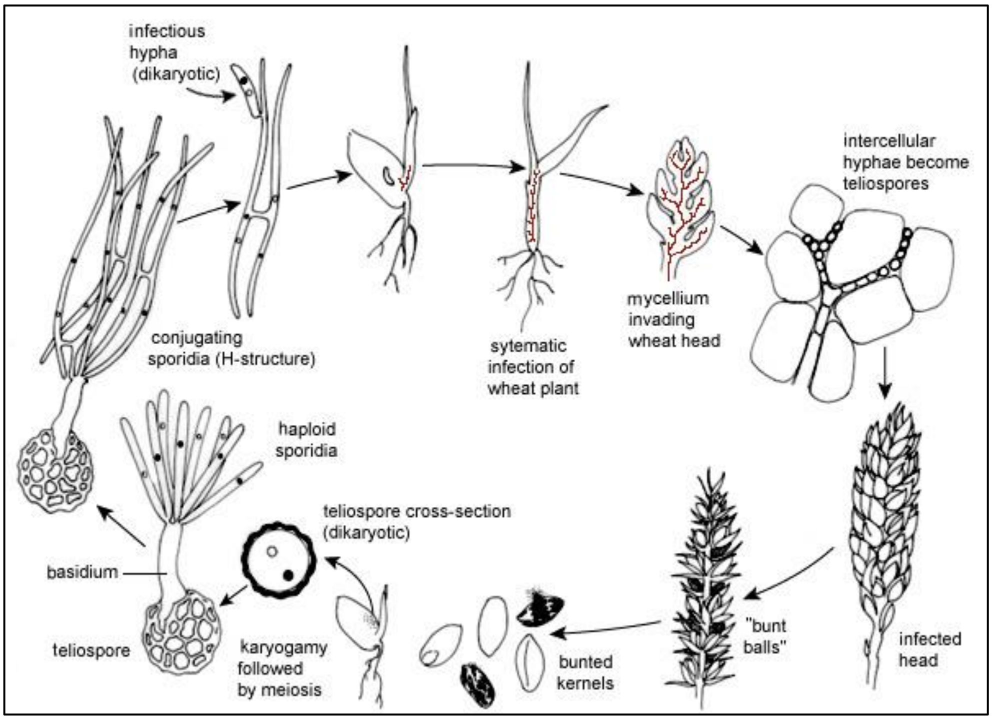
DISEASE CYCLE

- These two smut fungi survive between growing seasons as teliospores on the surface of healthy seed or in the soil. They can remain viable in either location for a number of years, perhaps ten years or more, particularly if the spores remain dry on the seed surface.
- When environmental conditions are favorable, each teliospore germinates, producing sporidia (basidiospores). After compatible sporidia anastomose (fuse) to form the H-shaped structure, the resulting dikaryotic, infectious hypha penetrates a seedling. As the plant grows, the fungal hyphae also grow, keeping pace with the apical meristerm. Eventually, the hyphae replace the cells of the seed, and the individual cells of the smut fungus become teliospores.

- During harvest, the smut spores are released from infected heads as the heads pass through the combine used to harvest the grain. They contaminate other seed being harvested or are spread by the wind to the soil surface, later to be incorporated into the soil mass during cultivation.

DISEASE MANAGEMENT

- **Seed Treatment :** Perhaps one of the greatest success stories in plant disease control is found in the use of chemical seed treatments for control of stinking smut. Early in the history of seed treatment, compounds containing copper were used, e.g., copper sulfate.
- **Resistant Cultivars of Wheat :** Stinking smut also can be controlled by the use of disease resistance. In the early part of the 20th Century when highly effective seed treatments were unavailable, a great effort was made by wheat breeders to produce smut-resistant cultivars.
- **Seeding Date :** The severity of stinking smut can also be manipulated to a certain extent by choosing a planting date when the soil temperature is above that for optimal teliospore germination, e.g., above 20°C (68°F).



7. Short notes on :

(i) Little leaf of brinjal

Host: *Solanum melongena* L. (brinjal)

Disease name: Little leaf of brinjal

Pathogen name: Mycoplasma like organism or phytoplasma

Symptoms :

a. This is a serious mycoplasmal disease of brinjal.
b. The leaves of the infected plants in the early stages are light yellow in colour.
c. The leaves show a reduction in size and are malformed.
d. Disease affected plant are generally shorter in stature bearing a large number of branches, roots and leaves than healthy plants.
e. The petioles get shorter considerably, many buds appear in the axil of leaves and internodes get shortened thus giving the plants a bushy appearance.
f. Flower parts are deformed leading the plants to be sterile. Infected plants do not bear any fruit. However, if any fruit is formed it becomes hard and tough and fails to mature.

Control :

a. Adopting sanitary measures including the eradication of susceptible volunteer crop plants from a previous planting can reduce the damage.
b. Use of barriers of trap crops and early removal and destruction of infected plants is also recommended.
c. The sowing time can be adjusted to avoid the main flights of the beet leafhopper. Spraying Malathion (2ml/litre of water) starting with the appearance of the leaf hoppers controls their population.

(ii) Wilt of arhar

Host: *Cajanus cajan* L. (Arhar)
Disease name: Wilt of Arhar
Pathogen name: *Fusarium udum*

Symptoms :

a. This disease is caused by fungus *Fusarium udum.*
b. The leaves of the affected plants turn yellowish in colour and drop.
c. This results in drying out of whole plant.
d. After removing the outer epidermal strip of the roots, black streaks on the wood are found.
e. The affected tissues become black.
f. The disease appears on young seedlings in August and highest mortality in mature plants is caused at the time of flowering in the months of November and December

Control :

a. Adopt 3-4 years crop rotation as the disease is soil borne.
b. Sow disease resistant varieties like F-18, F-52, ST-l, ST- 2 and ST-3 etc.
c. Remove the diseased plants carefully by hand, bum them outside the field so that the pathogens may not spread in the same field.