HISTORY OF PLANT PATHOLOGY

1. The history of Plant Pathology is as old as human civilization. Even when the humans lived as nomads and used to eat only leaves, fruits and seeds, plant diseases took their toll, causing leaves to mildew and blight and fruit and seeds to rot. When man began to grow one or few kinds of food plants, part of the crop was lost to diseases thus delimiting food supplies and hunger was common.
2. Homer, 1000 B.C: mentioned the therapeutic properties of sylph on plant diseases.
3. Democritus, 470 B.C: control of blights by sprinkling plants with the olive grounds left after extraction of the olive oil.
4. Theophrastus, 300 B.C: The Greek philosopher was the first to study and write about diseases of trees, cereals and legumes.
5. Magnus, 1200 A.D. in Germany proposed that the mistletoe plant was a parasite that obtained its food from the host plant, which it makes sick. He also noted that pruning out the parts carrying the mistletoe could cure the host plant.

THE ROLE OF FUNGI IN PLANT DISEASES

1. Leeuwenhoek, 1667: Spores of wheat rust fungus were observed with the compound microscope for the first time in England
2. Micheli, 1729: In Italy described many new genera of fungi. He proposed that fungi arose from their own spores rather than spontaneously, but nobody believed him.
3. Tillet, 1755: wheat plant become diseased {smut] on inoculation of seed healthy plant with smut dust. Smut incidence could be reduced by treating the seeds with copper sulphate before planting.
4. Prevost, 1807: repeated Tillet's inoculation and copper sulphate treatment experiments and he also observed with the microscope, the production and germination of smut spores, as well as the inhibition of spore germination with the addition of a drop of copper sulphate. He demonstrated that wheat smut is caused by a fungus.

5. Late blight of potato caused severe losses in much of Northern Europe in 1840s, but it absolutely destroyed the potato crop in Ireland in 1845 and 1846. Several scientists described various aspects of this disease and of a fungus that seemed to be always associated with the disease. Some scientists believed that the fungus was the primary cause of the foliage blight and associated tuber rot of potato.
6. DeBary, 1861: finally established experimentally that a fungus (*Phytophthora infestans*) was the cause of this plant disease.
7. Louis Pasteur, 1860-1863: finally provided evidence that microorganisms arise only from the pre-existing microorganisms and that fermentation is a biological phenomenon.
8. Kuhn contributed greatly to the studies on infection and development of smut in wheat plants. He also wrote the first book on Plant Pathology named as "Diseases of Cultivated Crops, their Causes and their Control".

DISCOVERY OF OTHER PATHOGENS AS CAUSES OF PLANT DISEASES

NEMATODES

1. Needham (1743) observed nematodes within small, abnormally rounded wheat kernels (wheat galls) for the first time. In 1855, a second nematode, the root-knot nematode, was observed in cucumber root galls. In the next four years two other plant parasitic nematodes, the bulb and stem nematode and the sugar beet cyst nematode, were reported. Cobb described several more nematodes during the 20th century.

BACTERIA

2. Pasteur and Koch, 1876: for the first time showed that an animal disease, known as anthrax, was caused by a bacterium. Based on his experiments of this disease,
3. Koch, 1882: proposed "Koch's Postulates", which are used to confirm the pathogenicity.
4. Burril, 1878: showed that fire blight disease of apple and pear was also caused by a bacterium. Erwin F. Smith recorded several other bacterial plant diseases.
5. Windsor and Black, 1972, observed a new kind of phloem inhabiting bacterium

causing the club leaf disease of clover. The next year, a still different kind of xylem inhabiting bacterium was observed in grape plants infected with a disease (Pierce's disease), which until then was thought to be caused by viruses.

VIRUSES

1. Mayer, 1886 reproduced the 'Tobacco Mosaic' disease by injecting juice from infected tobacco plants into healthy tobacco plants.
2. Ivanowski 1892, showed that whatever caused the Tobacco mosaic disease, could pass through a filter that retains bacteria, so he concluded that the disease was caused by a toxin secreted by bacteria or by unusually small bacteria that passed through the pores of the filter.
3. Beijerinck, 1898: finally concluded that tobacco mosaic disease was caused not by a microorganism but by a 'contagious living fluid', which he called a virus.
4. Stanely, 1935, crystallized the coat protein of virus. He was awarded a Noble Prize in chemistry in 1946.
5. Bawden 1936 and his colleagues demonstrated that the crystalline preparations of virus actually consisted of not only proteins but also a small amount of RNA.
6. Kausche, 1939: The first virus (TMV) particles were seen with the electron microscope in and his colleagues.
7. Gierrer and Schramm, in 1956, showed that it was the ribonucleic acid, which enabled the viruses to cause infection and not the proteins.
8. Diener, 1971: determined that potato spindle tuber disease was caused by a small (250-400 bases long), naked, single stranded, circular molecule of infectious RNA, which he called a viroid. So far more than 20 viroids have been found to infect plants.
9. Prusiner, 1982, an even smaller type of infectious agent was recorded by which he named as 'prion'. This apparently consists of only a small (~55,00 Da) pertinacious infectious particle, the protein of which is encoded by a chromosomal gene of the host. Prions have been shown to cause at least three slow-developing degenerative diseases of humans and the Scarpie disease of

sheep, but no such disease in plants has yet been recorded.

MOLLICUTES

Doi and his colleagues 1967, in Japan observed mollicutes i.e. wall less mycoplasma like bodies in the phloem of plants exhibiting yellows and witches' broom symptoms. The same year, the same group showed that the mycoplasma like bodies and the symptoms disappeared temporarily when the plants were treated with tetracycline antibiotics.

CONTROL OF PLANT DISEASES

Chemical control

1. Ancient Greeks, Homer (1000 B.C.), Democritus (470 B.C.) and Theophrastus (300 B.C.) were among the first ones who gave realistic recommendations for disease control.
2. 1600s farmers used brine (sodium chloride solution) to control the bunt of wheat.
3. In mid 1700s, sodium chloride was replaced with copper sulphate.
4. In early 1800s, lime-sulphur and aqueous suspensions of sulphur were recommended for the control of mildew of fruit trees.
5. Millardet, 1885, discovered the magical Bordeaux mixture for the of downy mildew of grapes in France. This fungicide is still widely used particularly in the developing countries.
6. In 1913, organic mercurial compounds were introduced for seed treatment. Such chemicals have been in extensive use until 1960s, when these were banned due to their toxicity.
7. In 1934, the first dithiocarbamate fungicide (thiram) was discovered, which led to the development of a series of effective and widely used fungicides including ferbam, zineb and maneb.
8. In 1965, the first systemic fungicide 'carboxin' was discovered followed by te introduction of several other systemic fungicides, such as benomyl.
9. Antibiotics, primarily streptomycin, were first used to control the plant diseases in 1950.

10. Soon after, the antibiotic Actidione was shown to be effective against several plant pathogenic fungi.
11. In 1967 tetracycline antibiotics were shown to control plant diseases caused by fastidious bacteria that live in the xylem of their host plants.
12. In 1954, it was noticed that some strains of phytopathogenic bacteria were resistant to certain antibiotics.
13. In 1963, strains of fungal plant pathogens were found, which were resistant to certain protective fungicides. This prompted to development of new strategies for plant disease control.

BIOLOGICAL CONTROL

1. Flemming, 1928: reported that *Penicillium notatum* inhibits the growth of other fungi and bacteria. Biological control with antagonistic microorganisms was started in 1963.
2. In 1972, Cross protection of disease.
3. the late 1980s, genetic engineering was introduced to control plant diseases.
4. In the early 1990s, non-toxic chemicals called plant defense activators were synthesized which activate the plant defense system. The first such compound (CGA-245704) was tested and marketed in 1996.

MECHANISM BY WHICH PATHOGENS CAUSE DISEASE

1. DeBary, 1886: reported that *Sclerotinia* spp. produces enzymes and toxins that degrade and kill plant cells from which the fungus can then obtain its nutrients.
2. In 1905 cytolytic enzymes, involved in several soft rot diseases of vegetables caused by bacteria, were reported by L.R. Jones. A bacterium *Pseudomonas tabaci*, the cause of wildfire disease of tobacco, produces a toxin. This toxin was isolated in pure form in 1950. In 1947, *Helmintosporium* (*Bipolaris*) spp. that attacked oats and produced a toxin called victorin, was discovered.
3. In 1939, Giberellin, a growth regulator produced by a fungus (*Giberella fujikuori*), was isolated, identified and named. In late 1950s, many

phytopathogenic fungi and bacteria were shown to produce the plant hormone indoleacetic acid (IAA). In the mid 1960s, a cytokinin was shown to be produced by the bacterium that causes the fasciation (leafy gall) disease of peas and other plants, and the symptoms of the disease could also be reproduced by treating the healthy plants with kinetin, which is an animal derived cytokinen.

Father of virology	**Martinus Beijerinck**
Father of mycology	**Heinrich Anton de Bary**
Father of nematology	**Nathan Augustus Cobb**
Father of bacteriology	**Louis Pasteur**
Father of Plant Pathology	**Heinrich Anton de Bary**