The diseases caused by pathogens on plants are the result of biochemical reactions that take place between substances secreted by the casual agents and those present within the plants.

The activities of pathogens in plants are mostly chemical in nature.

The substances secreted by plants are responsible for causing the disease either directly or indirectly. These substances are enzymes, toxins, growth regulators, polysaccharides and antibiotics.

These groups of chemical substances vary in pathogenicity.

Enzymes, toxins and growth regulators are common and most important in development of plant disease.

All plant pathogens produce enzymes, toxins, growth regulators, polysaccharides except viruses.

Fungi and bacteria produce antibiotics.

These plant viruses induce the host cell to produce certain amount of substances.

**Enzyme**

- The enzymes are proteins molecules 2-100 mμ in diameter, which catalyze all the interrelated reactions in a living cell. A cell contains several million enzymes, which belongs to different kinds of enzymes.
- Plant pathogenic enzymes disintegrate the host cells; break food substances present in the cell and interfere with its functioning systems.
- Enzymes secreted by microorganism play a key role in disease development. These break down plant substances into smaller molecules which pathogen easily absorb and utilize for its growth and energy.
- **Hydrolases** is most important enzymes involved in the production of disease by plant pathogens.
- Complete plant tissue disintegration involves break down of lignin.
- Pectin which is the main component of middle lamella is polysaccharides are known to degrade by several enzymes.
- Cellulose degrading enzymes are produced by several phytopathogenic fungi, bacteria and nematodes.
- In living plants tissues, cellulytic enzymes secreted by pathogens play a role in the softening and disintegration of the cellulose cell walls.
- **Hemicelluloses** an integral part of cell wall are mixture of water insoluble polysaccharides and lignin of plant cell walls. Hemicellulloses disintegrate these hemicelluloses.
- Lignin found in middle lamella, in cell wall of xylem vessels, in fibres; in epidermal and hypodermal cell. **Ligninase** degrade lignin. Enormous amounts of lignin are degraded by microorganisms in nature. Brown rot fungi and white rot fungi are capable of degrading lignin.
- **Proteolytic enzymes** catalyze the hydrolysis of peptide linkages. The degradation of host proteins by proteolytic enzymes secreted by pathogens affects the organization and function of the host cell.
- Starch is polysaccharides found cell is synthesized in chloroplast and amyloplast. Most pathogens utilized starch and other polysaccharides, in their metabolic activities. The degradation of starch is brought about by the action two enzymes **α-amylase** and **β-amylase**. **Isoamylase** is also responsible for degradation of starch.
- Many fungi, bacteria, nematodes are capable of degrading lipid. Lipolytic enzymes like **lipases**, **phospholipidases** etc. hydrolyze the liberation of fatty acids from the lipid molecules. Fatty Acid is directly utilized by the pathogen.
- All living cells contain small amounts of ribonucleic acid (RNA) and deoxynucleic acid (DNA). DNA is found in nucleus and small amount in chloroplast and mitochondria. RNA is found in the cytoplasm, ribosome, mitochondria, nucleolus and chloroplast. Several pathogenic fungi and bacteria degrade nucleic acids.

**Toxins**

- Living plant cells are complex bodies in which many independent biological reactions take place. Metabolic reaction disrupts the physiological processes that lead to development of plant disease. The factors which disrupts are metabolites are Toxins which directly act on living host protoplast and kill the cells of the plant.
- During host pathogen reaction certain chemical substances are produced by pathogen which are responsible for disease symptoms in plant. These chemical substances are called toxins.
- Fungi and bacteria may produce toxins in infected plants and as well in culture media.
- Toxins are extremely poisonous and effective in very low concentrations.
- Toxins injure host cell either by affecting osmotic relations or by affecting enzymatic reactions going on in the plant cells.
- Most toxins have a direct or indirect effect on the respiration of the plant.
There are various toxins which play role in developing plant diseases. Some of them are:

- **Phytotoxins**: Produce by fungi or higher plants.
  1. **Pathotoxins**: These are able to produce in susceptible host plants. All characteristic disease symptoms but have little or no effect on resistance species.
  2. **Vivotoxins**: Produce portion of disease symptoms.

- **Endotoxins**: Intercellular toxins. Formed in bacterial cells and not liberated until the latter die.

- **Exotoxins**: Extracellular toxins which diffuse from living bacterial cell.

- **Pleiotropic toxins**: Toxins produced by plant pathogens having multiple effects on host cells.

- **Monotropic toxins**: Produce by bacteria which attack animals. This is unstable toxins.

- **Marasims or wilting toxins**: Cause loss of cell turgor and leaf flaccidity.

- **Necrotoxins**: Cause necrosis.

- **Zootoxins**: Produce by animals.

- **Toxins produced by Fusarium**: Many species of *Fusarium* are responsible for causing wilt diseases on a number of plants. **Lycomarasmin** cause wilting and necrosis between the veins of excised tomato leaves. **Fusaric acid** induces wilting in tomato cuttings. **Dehydrofusaric acid** is also isolated from *Fusarium* and can easily be converted into fusaric acid.

- **Toxins produced by Pyricularia**: The toxin **Pyricularin** reproduces the disease symptoms in seedling and in mature plants. It is a fairly potent toxin that affects a number of species of higher plants and microorganism. Low concentration of pyricularin stimulate growth and respiration of the host, but higher concentrations inhibit both.

- **Some other toxins**: **Alternaric acid** isolated from *Alternaria solani* cause early blight of potatoes and tomatoes. **Colleotin** isolated from *Colletotrichum fuscum* is causal organism of anthrancnose of *Digitalis*. Victorin isolated the fungus *Helminthosporium victoriae*. It consists of a peptide, which on hydrolysis yields aspartic acid, glutamic acid, glycine, valine and leucine.

Photographs were taken from Google

Books Cited: