Ans. The pathogen employs offensive chemical weapons to breach host barriers which are resisted by the host with all its might. Enzymes; toxins; growth regulators; Polysaccharides antibiotics are the important chemical weapons of the pathogen.

Decomposition and disintegration of host tissues are the important constant components of plant disease syndrome. Enzymes and the toxins are the main aspects under which the mechanism of disease has been studied in the last 60 years or so. The concept that cell wall degrading enzymes may be involved in pathological manifestations induced in plant tissues by biotic agents was introduced for the 1st time by De. Bary's work on extracellular enzymes of Sclerotinia Libertiana in 1886. He described the two types of actions, studying the mode of invasion dissolution of middle lamella and the killing of the cells. The two factors are known as macerating and killing factors.

The role of oxalic acid as a killing factor was again proposed by Smith (1902 for Botrytis cinerea which was later disproved by Prof. William Brown of London (1915) L.R Jones (1905) reported the production of pectic enzymes by soft rot bacteria Brown demonstrated (1915,17) that a pectic enzyme protopectinase was involved in maceration of tissues by Bacteria. He could not separate the killing factors from the macerating factors. Pectic enzymes have received great attention after 1950 (Mandels and Reese 1965 Hussain and Kalwar 1959; chan and

Barksdale 1970 : Goel and Mehrotra 1973 : 1974 : Mahadevan 1970).

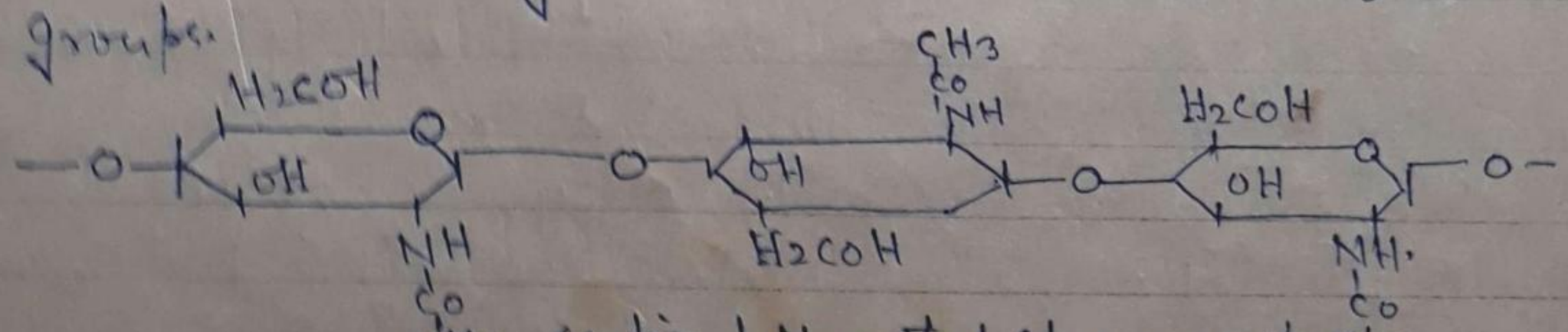
In most plant diseases caused by microbial agents cellwalls are penetrated : tissues are colonized and permeability of host cells is altered. An understanding of the cellwall and membrane str. together with a knowledge of enzymes capable of degrading the components of these structures is essential for our understanding of disease physiology.

Composition of cellwall :-

Epidermal cells have an array of lamellae made up of epidermal cells different chemical substances as follows:

Plant waxes :- The wax present on plant surface usually covers the cuticle and tries to prevent the direct entry of the pathogen. No pathogen is known to act on cuticular wax usually there is 30-35% upto a maxm; of 60% wax. Since no enzyme is known to act on wax; its only mechanical pressure of the pathogens which helps it into entering the host by applying force.

CUTIN :- The major chemical substance of cuticle is Cutin and forms about 80-40% of its bulk chemically it is polyester of hydroxylated monocarboxylic acid each containing 16-18 carbon atoms and 2-3 OH groups.



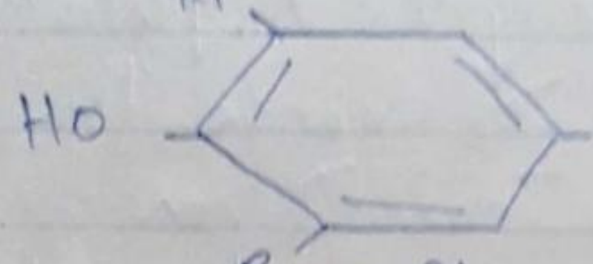
(Cutin 1-N-acetyl glycose units)

At present Cutin is regarded only as mechanically penetrable.

The cell of higher plants comprises a middle lamella and primary cellwall. Sometimes a sec. cellwall.

Pectic substances are the basic constituents of wall layers and form almost the middle lamella; whereas in the other layers cellulose is also found in good amounts. Besides these two major groups of compounds other components are hemicellulose, lignin, proteins and limited amount of other materials.

Lignin:- It forms 15-38% content of woody plants and is next only to cellulose in abundance. It occurs mainly in epidermal cellwalls and xylem vessels.

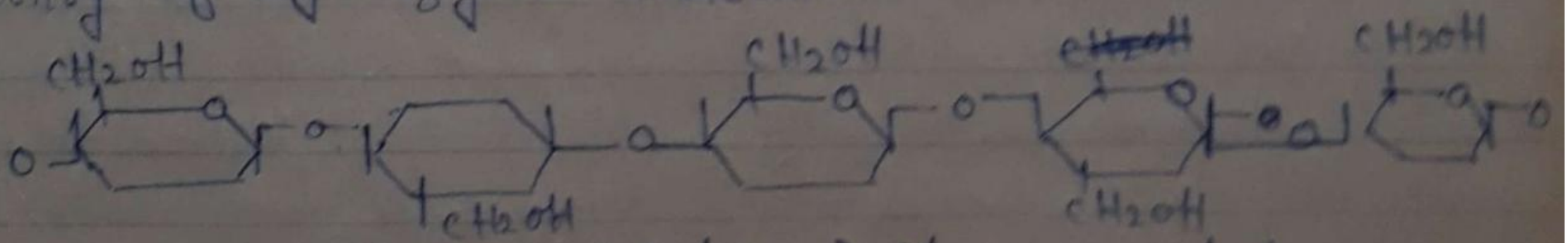


(Phenyl propane molecule: R and R1 either OCH3 or H)

It is a polymer of phenyl propane units formed from shikmic acid but chemists are not yet certain about its chemical str. and composition (Freudenberg 1968; Kirk 1971)

Lignin decomposing enzymes are produced by woodrotting fungi; which produce an enzyme transmethylase which modifies lignin for further degradation by cellulolytic enzymes.

Cellulose:- It is the major component and basic unit of structural framework of plant cellwall. It is a polymer of β-glucose units joined by β-1,4 glycosidic linkages. A single cellulose chain passes through several crystalline and amorphous areas in the fibril. Crystalline areas are resistant to enzyme attack as high orientation prevents entry of big enzymes molecules.



(Cellulose β 1-4 linked glucose units)

Cellulolytic Enzymes:- Information about cellulolytic enzymes has come mostly from studies on rotting and decay fungal deterioration of manufactured cellulose {like

enzymic degradation of cellulose is imperfectly understood] Cellulose degrading enzymes are produced by fungi, bacteria and nematodes and also by parasitic higher plants. They cause:

1). The break up of the wall barrier for entry.

2). Provide food in the form of glucose from cellulose on hydrolysis.

The enzyme cellulases degrade cellulose and its derivatives. Cellulases which degrade native cellulose by destroying its crystalline str. are characterised as C1 enzyme and expose the glycon chains of β-1,4 endoglycanases; Termed as enzymes which degrade the glucan chains to cellobiose (Reese 1956). The conversion of cellulose to glucose also requires a cellobiose a β-glycosidase. The presence of cellulolytic enzymes and degradation of cellulose by bacteria and fungi have been reviewed by Mandels (1965), Norkrans (1963), Gascoigne and Gascoigne (1960); Siu and Reese (1951); Greathouse and Wessel (1951) and Reese (1957).

There are two theories to explain the mechanism of cellulose degradation.

2) The uni enzyme theory (Whittaker 1953-57; Arai et al 1950)

4). The multi enzyme theory (Reese 1950)

The uni enzyme theory envisages complete degradation of cellulose into glucose units by a single enzyme. Whittaker (1954) obtained an electrophoretically pure enzyme from Myrothecium verrucaria; which degraded native cellulose to glucose. Arai et al (1956) while agreeing with above theory implicate the involvement of cellobiase enzyme to release glucose from the cellobiose which is produced by a single cellulase enzyme. It occurs in certain wood rotting fungi.

Native cellulose $\xrightarrow{\text{cellulase}}$ cellobiose $\xrightarrow{\text{cellobiase}}$ Glycose.

The multienzyme theory explains cellulose degradation in a series of steps as represented below:-

Native cellulose $\xrightarrow{C_1}$ Reactive cellulose $\xrightarrow[\text{(hydrolytic cleavage}]{\text{ex endoenzymes}}$ cellulose chains

$\xrightarrow[\text{ex exoenzymes}]{}$ cellobiose $\xrightarrow[\text{(hydrolytic)}]{\text{cellobiase}}$ Glycose.

Both mechanisms may be operative under different situations under different organisms. Cellulolytic enzymes have been implicated with diseases. Hussain and Kelwan 1957; 1958; Talboys (1958) Hussain and Drmond 1960.