

Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Botany

Course Code: BOC 106

Course Title: Cell Biology and Plant Biochemistry

Unit: Unit 4- Biomolecules

Module Name: Structure and properties of polysaccharides (starch and cellulose)

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Notes

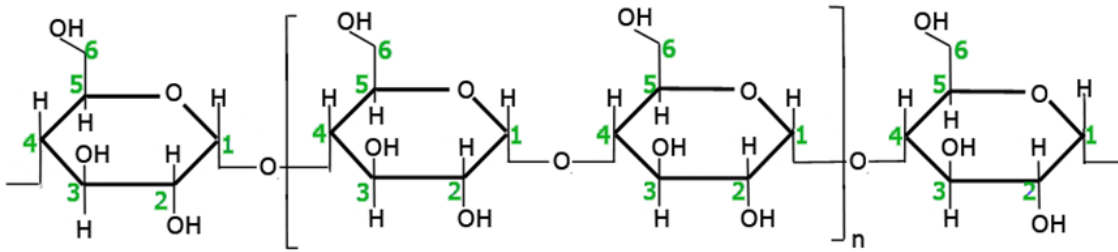
Introduction to polysaccharides

Polysaccharides are high molecular weight carbohydrates which on hydrolysis yield mainly monosaccharides or related products. They are also called glycans. When polysaccharides are made up of only glucose units they are called glucans.

Structure of starch

Starch consists of two components- amylose and amylopectin. Amylose is a long, unbranched, straight chain component. It constitutes 15 to 20% of the natural starch, whereas amylopectin is a branched chain polysaccharide and it constitutes 80 to 85% of natural starch. Potato contains 70 to 80% amylopectin, whereas the waxy corn (a mutant variety of corn) contains all amylopectin.

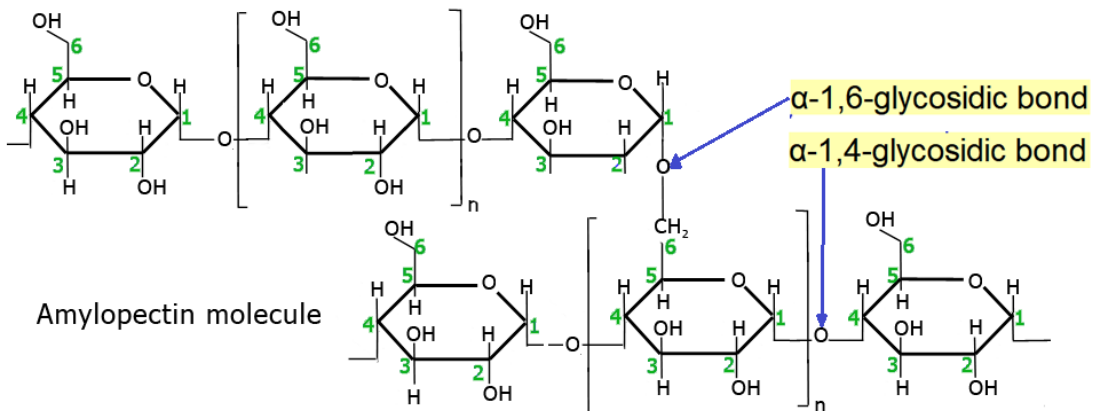
1. Amylose or α -Amylose- Amylose is an anhydride of α -D-glucose units. It is formed through glycosidic bonds between the first and the fourth carbon of adjacent α -D-glucose molecules, resulting in the loss of a water molecule.



Amylose molecule

2. Amylopectin or β -amylose or iso-amylase

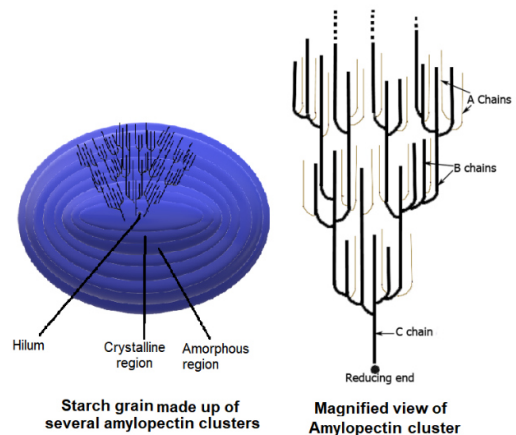
Amylopectin has a molecular weight much higher than that of amylose. It possesses the basic chain of α -1,4-glycoside (same as α -amylose), but in addition it also has many side chains attached by α -1,6 glycosidic linkages. The average chain length is about 24 to 28 glucose units.



Amylopectin molecule

Amylopectin is composed of three types of chains- A, B and C. A-chains are linked to B-chains, these B-chains are linked to other B-chains and the terminal B-chain is linked to a single C chain.

The starch molecule has a central (sometimes eccentric) hilum. It has crystalline and amorphous regions alternating with one another making it semi-crystalline in nature.



Starch grain made up of several amylopectin clusters

Magnified view of Amylopectin cluster

Difference between amylose and amylopectin

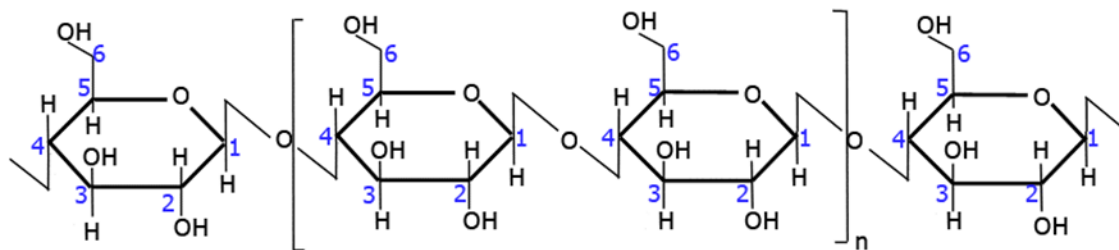
Amylose	Amylopectin
<ul style="list-style-type: none">• Unbranched chain	<ul style="list-style-type: none">• Branched chain
<ul style="list-style-type: none">• Simpler structure	<ul style="list-style-type: none">• Complex structure
<ul style="list-style-type: none">• Amylose does not swell in hot water	<ul style="list-style-type: none">• Swells in water to form amylose gel
<ul style="list-style-type: none">• Produces blue colour when reacted with iodine	<ul style="list-style-type: none">• Produces purplish red colour when reacted with iodine

Properties of starch

Starch is a homopolysaccharide. It is a nutrient or storage polysaccharide. It occurs widely in plants especially in the storage organs like the roots, tubers, seeds and fruits. It is semi-crystalline in nature. It lacks sweetness. It is insoluble in water, alcohol or ether at room temperature. The microscopic form of the starch grain is characteristic of the starch source. On partial hydrolysis, starch breaks down into larger fragments, called dextrans. Starch molecule is highly hydrated since it has many exposed hydroxyl groups. Therefore, when starch is extracted in hot water, it forms a turbid colloidal solution. Starch is a non-reducing polysaccharide, since all except one of its carbonyl groups is involved in glycosidic bond formation.

Structure of cellulose

Cellulose is derived from β -D-glucose units which condense through β -1,4-glycosidic bonds. Carbon atom 1 of one β -D-glucose molecule forms a glycosidic linkage with carbon atom 4 of the adjacent β -D-glucose molecule.

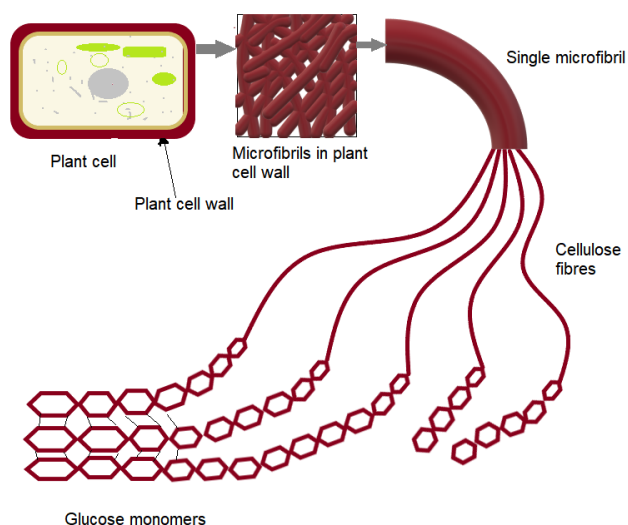


Cellulose molecule

Cellulose is a straight chain polymer. There is no coiling or branching as seen in starch. The molecule has an extended and stiff rod-like conformation. Multiple hydroxyl groups of glucose from one chain forms hydrogen bond with the neighbouring chain. This holds the chains together, forming micro fibrils with high tensile strength. Many such microfibrils will be arranged one over the other to form the plant cell wall. The high tensile strength also arises from the close arrangement of cellulose fibres in the lignin matrix.

Properties of cellulose

Cellulose is a homopolysaccharide because it is made up of only glucose units. It is the most abundant extracellular structural polysaccharide of the plant world. It occurs in nearly pure form in cotton (94 %) and flax (90 %). It is fibrous, tough and white solid. It is insoluble in water but soluble in ammoniacal cupric hydroxide. It is odourless and



it lacks sweetness. Cellulose is absorbent to water. It is an important biomolecule in industries, particularly the paper and the cloth industry. In humans, cellulose has no nutritive value, since the enzymes responsible for cleaving the β -glycosidic bonds are absent. Ruminants, like the cattle, sheep, goat, camel and giraffe, and certain wood eating insects and wood rot fungi are able to digest cellulose because they have the required enzymes.
