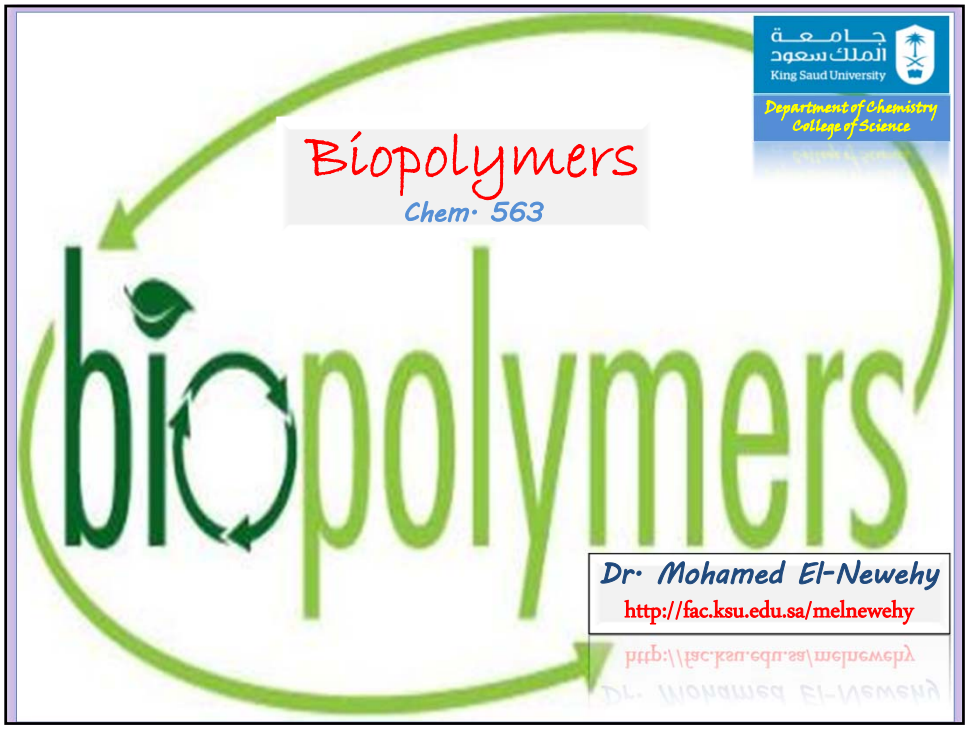
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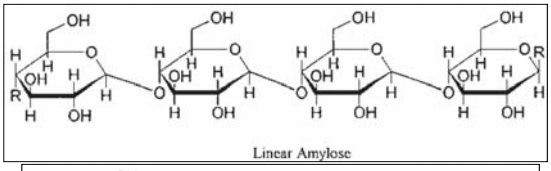
STARCH

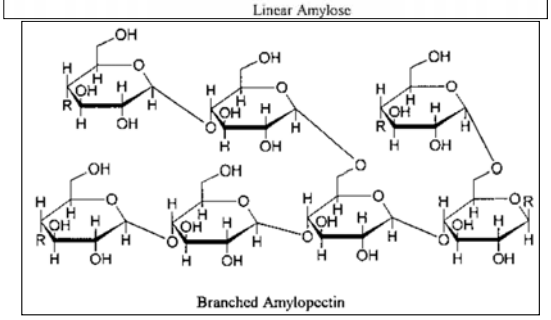
- Starch is the second most abundant polysaccharide after cellulose.
- It is widely distributed in plants where it is stored as reserve carbohydrate in seeds, fruits, tubers, roots, and stems.
- Plant energy storage and regulation utilizes a combination of similar polysaccharides that combined are referred to as starch.
- The two major components of starch are called ***amylopectin*** (the major constituent) and ***amylose*** (the minor constituent).
- Starches are usually present in the form of intramolecularly hydrogen-bonded polymer aggregates or granules.
- Commercially starch is prepared from corn, white potatoes, wheat, rice, barely, millet, cassava, tapioca, arrowroot, and sorghum.

- ***Amylopectin***, which is sometimes **called the B fraction**, is usually the major type of starch present in grains.
- ***Amylose***, which is sometimes **called the A fraction**.
- Thus, the fraction of amylopectin and amylose varies with respect to the particular plant and the usual weather, age, and soil conditions.
- Amylose serves as a protective colloid.
- Mixtures of amylose and amylopectin, present in native starch, form suspensions when placed in cold water.
- An opalescent starch paste is produced when this suspension is poured into hot water.
- Most starches contain about **10–20% amylose** and **80–90% amylopectin**, though the ratio can vary greatly.

- **Amylose** is a linear polysaccharide with glucose units linked in an α-1,4 fashion.
- **Amylopectin** contains glucose units with chains of α -1,4 glucopyranosyl units but with branching occurring on every 25–30 units, with the chain branch occurring from the 6 position.



Linear Amylose



Branched Amylopectin

Starch versus Cellulose

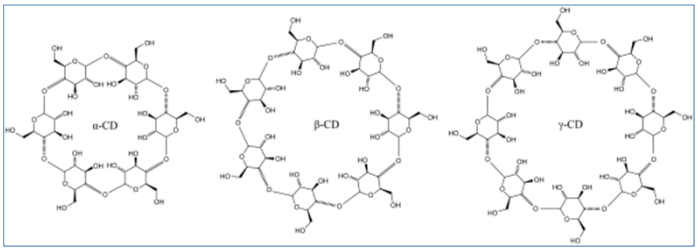
- Humans contain enzymes that degrade the α-glucose units of starch allowing it to be metabolized as a major food source but we are not able to convert the β unit, found in cellulose, into glucose so that wood and other cellulose-intensive materials are not food sources for us.
- Also, the individual units of cellulose can exist in the chair conformation with all of the substituents equatorial, yet amylose must either have the glucosyl substituent at the 1 position in an axial orientation or exist in a nonchair conformation.

- *Starch* can be divided into two general structures, **branched amylopectin** and largely **linear amylose**.
- **Amylose** typically consists of over 1000 D-glucopyranoside units.
- **Amylopectin** is a larger molecule containing about 6000 to 1,000,000 hexose rings essentially connected with branching occurring at intervals of 20–30 glucose units.
- Branches also occur on these branches giving amylopectin a fan or treelike structure similar to that of glycogen.
- Thus, amylopectin is a highly structurally complex material.
- **Amylose** has the ability to form a blue-colored solution in the presence of iodine.
- Amylopectin also interacts with iodine, it does so much more weakly giving a reddish-purple complex.

- *Starch* granules are insoluble in cold water but swell in hot water.
- As the water temperature continues to increase to near 100°C, a starch dispersion is obtained.
- Oxygen must be avoided during heating or oxidative degradation occurs.
- Both amylose and amylopectin are then water-soluble at elevated temperatures.
- Most uses of starch make use of the high viscosity of its solutions and its gelling characteristics.
- Modification of starch through reaction with the hydroxyl groups lowers the gelation tendencies decreasing the tendency for retrogradation.
- Starch is the major source of corn syrup and corn sugar (dextrose or D-glucose).
- In addition to its use as a food, starch is used as an adhesive for paper and as a textile-sizing agent.

Cyclodextrins

- Oligomeric or small-chained materials are formed when starch is treated with a particular enzyme, the amylase of *Bacillus macerans*.
- These oligomeric derivatives generally consist of six, seven, eight, and greater numbers of D-glucose units joined through 1,4-α linkages to form rings.
- These rings are doughnut-like with the hydroxyl groups pointing upward and downward along the rim of the doughnut.



α (alpha)-cyclodextrin: 6-membered sugar ring molecule
β (beta)-cyclodextrin: 7-membered sugar ring molecule
γ (gamma)-cyclodextrin: 8-membered sugar ring molecule

Cyclodextrins

- The cyclodextrins can act as "host" to "guest" molecules.
- ***Cyclodextrins*** have a polar exterior and nonpolar interior.
  - The polar exterior allows the cyclodextrins, and often the associated guest, to be water-soluble.
  - The nonpolar interior allows nonpolar molecules to be guest molecules.
- ***Cyclodextrins*** are being used as enzyme models since they can first bind a substrate and through substituent groups, act on the guest molecule—similar to the sequence carried out by enzymes