MMBB 300/380 Exam 3 Reading Assignment
Reducing Sugars, Disaccharides & Polysaccharides
Lehninger 4th Ed: pp 244-253

<u>Concepts & Questions</u>

1. What are reducing sugars? What are non-reducing sugars?
2. What is an *O*-glycosidic bond? What does hydrolysis of a glycosidic bond achieve?
3. What is the reducing end of a disaccharide or polysaccharide?
4. How do maltose & lactose differ?
5. What is sucrose?
6. What are the three main forms of polysaccharides that serve as storage forms of glucose? What kind of polymers are these?
7. How are cellulose and chitin related?
8. What is agar and agarose?

<u>Answer Key</u>

1. **Reducing Sugars:** Aldoses such as glucose have aldehydes that can act as mild reducing agents. In such a reaction, the aldehyde is oxidized to a carboxylic acid. For many years, sugars were classified as either reducing or non-reducing sugars. Ketoses, like fructose, are not as easily oxidized and are classified as non-reducing sugars.
2. ***O*-Glycosidic Bond:** When sugars polymerize, the monosaccharides are linked together by *O*-glycosidic bonds. These bonds include the anomeric carbon (carbonyl carbon) of one sugar and the hydroxyl group (alcohol) of a second sugar. Hydrolysis of glycosidic bonds regenerate the monosaccharides.
3. **Reducing & Non-reducing Ends:** When an anomeric carbon is involved with a glycosidic bond, it is no longer available as a weak reducing agent. Thus, sugars whose anomeric carbon is tied up in a glycosidic bond and are found at the end of a polysaccharide (or disaccharide) are said to be at a non-reducing end (there can be multiple non-reducing ends in a branched polymer of sugar like glycogen).Any sugar with a free anomeric carbon which is also found at the end of a polymer is considered the reducing end of that polymer. By convention, non-reducing ends are typically drawn on the left of a polymer and reducing ends are drawn on the right.
4. **Maltose & Lactose:** Both are disaccharides. Both contain 1→4 O-glycosidic bonds. They differ in that maltose is a homodisaccharide of glucose while lactose is a heterodisaccharide containing both galactose and glucose. In addition, maltose has an α1→4 linkage while lactose has a β1→4 linkage. The non-reducing sugar of maltose is in the alpha configuration while the non-reducing sugar of lactose is in the beta configuration. Hydrolysis of one maltose would generate two glucose molecules. Lactose is unique to mammalian milk and is considered milk sugar. Adult mammals frequently lose the ability to hydrolyze lactose (catalyzed by lactase) and, thus, are considered to lactose-intolerant.
5. **Sucrose:** Sucrose is a disaccharide of glucose and fructose. It is made by plants but not animals. Sucrose is a non-reducing sugar because the anomeric carbons of both the glucose and the fructose are tied up in the glycosidic bond. You should know the structure of sucrose.
6. **Starch, Glycogen & Dextran:** All three of these are simply polymers of glucose. Starch is made by plants and consists of a mixture of amylase, long unbranched polymers of α1→4

linkages and amylopectin which also contains α1→6 branches. Glycogen is made by animals and is similar to amylopectin in that linear polymers of glucose contain α1→4 linkages and branches are made using α1→6 linkages. Bacteria & yeast make dextran which has linear polymers linked by α1→6 glycosidic bonds and branches can be made using α1→2, α1→3 or α1→4 bonds.

7. **Cellulose & Chitin:** These are both linear homopolysaccharides that are linked exclusively by β1→4 linkages; both serve significant structure roles. Cellulose, which makes up most of the mass of wood and cotton, is nothing more than a linear polymer (often 10,000-15,000 sugar residues) of glucose. The β1→4 linkages of both polymers generate structures that are significantly stabilized by hydrogen bonding (see Fig 7-16 & 7-19). Chitin is nothing more than a linear polymer of glucose that carries an *N*-acetyl group on carbon #2 (see Fig 7-18).
8. **Agar & Agarose:** Agar is found in the cell wall of some marine red algae; agar is harvested for its gel-like properties. It is used to make solid media for growing microorganisms (bacteria, yeast, algae, etc), to generate agarose gels for DNA & RNA electrophoresis, to make gel caps for various drugs and vitamins and, my favorite, as a thickener for ice cream. Agar is a combination of two sulfated polysaccharides, the branched agaropectin and the unbranched agarose. When dissolved in hot water, the agarose will form double helices that interact with one another to trap significant amounts of water resulting in gels upon cooling.