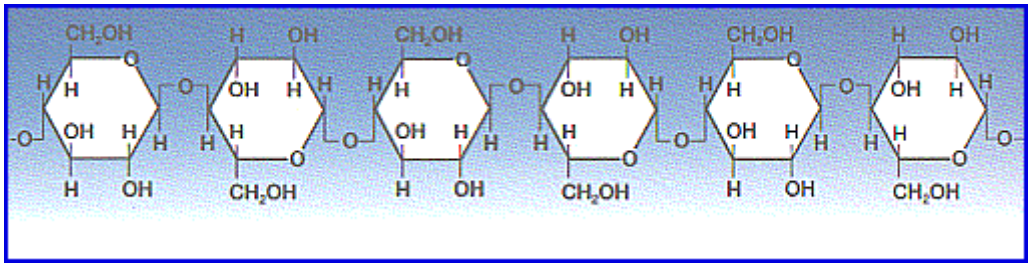
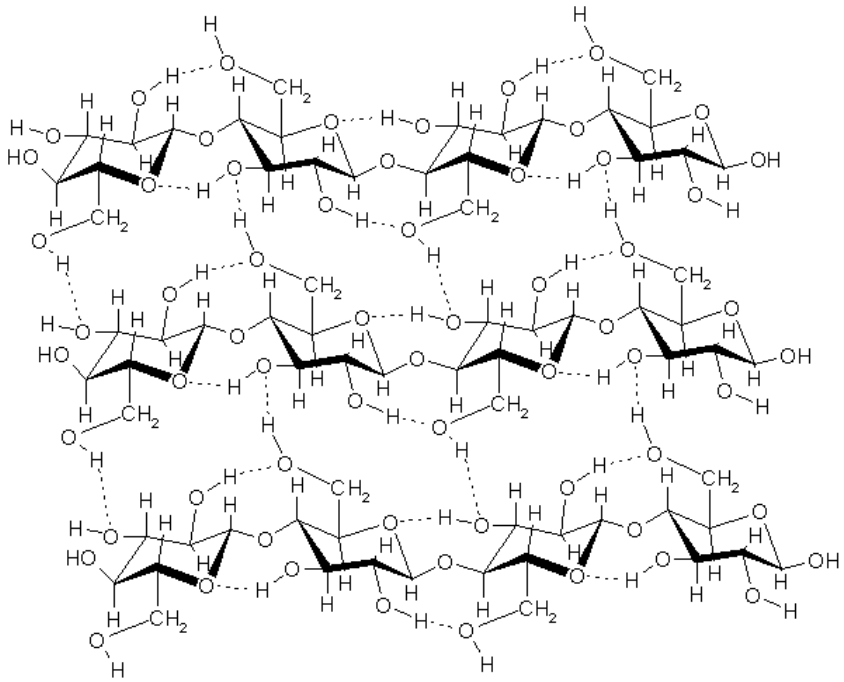
Additional Notes on Cellulose

Cellulose, the most abundant molecule in the biosphere, is found in plants as microfibrils (2-20 nm diameter &100 – 40,000 nm long). The microfibrils form a strong matrix that supports the structure of the plant. It is estimated that approximately 50% of the organic carbon atoms in the world are present as cellulose. Cotton and paper are composed almost entirely of cellulose.

The molecule cellulose is a polymer (large molecule composed of repeating units) built from at least 500 units of a naturally occurring sugar. The sugar components form long, rigid, strands. This gives cellulose fibers great strength.



The individual linear strands of sugar molecules form a closely packed sugar matrix held together by a network of hydrogen bonds (dashed lines; we will discuss these bonds in unit 11) between the linear sugar polymer strands.



This structure has the potential of forming numerous additional hydrogen bonds.

Water (H-O-H) is a hydrogen bond donor (and acceptor). As such, it can interact with the cellulose matrix. In essence, cellulose is acting as a molecular sponge to grab water molecules via hydrogen bond formation.

So, the absorbency of paper towels is a function of this hydrogen bond formation (mutual attraction) between water and cellulose. The paper towels that have the greatest density of cellulose will hold the most water.

Cotton Fabric

Cotton is a fantastic summer fiber. This is because cotton (cellulose) is a polar material (we will discuss this polarity in unit 11) and thus, readily absorbs water. A little bit of air movement and the evaporation of this absorbed water creates a comfortable cooling effect. This same cooling effect so appropriate during the summer, will dramatically speed heat loss in cold (particularly wet) environments. Fogery, in DEATH BY EXPOSURE suggests that wearing cotton jeans during the winter in outdoor activities can significantly reduce survival chances. So, to stay warm in cold climates, keep the first layer next to the skin a synthetic fiber that will not absorb water.

All natural fibers, including wool, will absorb water. Thus, all natural fibers, when wet, will eventually lose their insulation value and become quite useless as a protection from the cold. This is because water removes heat from your body 25 times faster than dry, still air. So, to stay warm, you must stay dry.