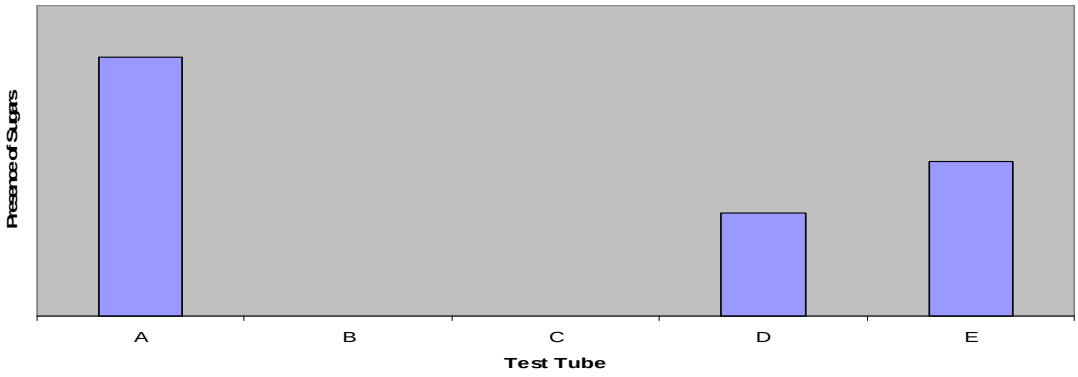
Analysis of Carbohydrate Polymers

Summary: My group and I tested the readiness of certain complex carbohydrates to break down into their glucose monomers by using samples of cellulose and starch. We used water and hydrochloric acid solutions, along with heating, to attempt to break each polymer type into its subunits, then tested for the presence of sugars with Benedict's Test Reagent. Our results indicated that the β-glucose within cellulose broke down in these tests, while the α-glucose in the starches did not. This would seem consistent with the behavior of these polymers as β-glucose is a structural material for cells while α-glucose are broken down by starch-hydrolyzing enzymes, which were not present in this experiment *(Raven et al., 2008)*. Different substances may be required to break down starches, such as the inorganic phosphates that must be present for starch decomposition within spinach chloroplasts *(Peavey et al., 1977)*.

Methods & Results: For this experiment, my group cleaned and labeled five test tubes, obtained a test tube heater block set to ~100°C, kept a ready supply of litmus paper to verify pH, and used 6M hydrochloric acid and sodium hydroxide solutions. Test tube A contained a mixture of 1mL glucose and 1mL water solution. Test tube B contained a mixture of 1mL starch solution and 1mL water. Test tube C contained a mixture of 1mL starch solution and HCl. Test tube D contained 2mL of water and one toothpick rinsed in water and broken into small pieces. Test tube E contained a mixture of 1mL of water and 1mL of HCl, and one toothpick rinsed in water and broken into small pieces. The solutions in all test tubes were mixed thoroughly. We placed test tubes C and E within the heater block and let them sit for 10 minutes. Upon completion, these two test tubes were neutralized with NaOH and tested frequently with the litmus paper during the process to achieve a pH value between 6-8, which is an appropriate pH range for sugar reactions to occur with Benedict's Test Reagent. Finally, we added ~2mL of Benedict's solution to each test tube and placed all of them within the heater block for 5 minutes to assist with any reactions that might occur.

Any change from the color blue introduced by the Benedict's Test Reagent would indicate a presence of sugars. This produced the following experimental results:



Test tube A, which served as our control sample, turned a strong pink color, indicating the greatest presence of sugars. The mixtures in test tubes B and C remained blue in color, indicating that there was little to no reaction with the Benedict's Test Reagent. Test tube D turned a light green color, indicating a weak reaction and small amount of sugars. Finally, test tube E turned a yellow-brown color, indicating a moderate reaction and medium amount of sugars. This data suggests that only the β-glucose chains found in cellulose can be broken down with HCl and heat and that α-glucose chains require the proper starch-hydrolyzing enzymes or different experimental methods than those employed here.

References:

Raven, P. & Johnson, G. & Losos, J. & Mason, K. & Singer, S., 2008. *Biology*, 8th ed., McGraw-Hill.

Peavey, D. G. & Steup, M. & Gibbs, M., 1977. Characterization of Starch Breakdown in the Intact Spinach Chloroplast*, Plant Physiology*, 60, pp. 305-308.