

Highlights Carbohydrates II

1. Chitin is a polysaccharide of insects that is composed of repeating subunits of an amino sugar (N-acetylglucosamine).
2. Bacterial cell walls contain carbohydrate polymers cross linked with short peptides containing D amino acids.
3. Polymers of anionic carbohydrates in proteoglycans create "slippery" solutions in water due to the repulsion of the many negative charges.
4. Glycoproteins are constituents of antibodies and can stimulate an antigenic (immune) response. Glycoproteins are the form of the carbohydrates described in class previously that give identity to cells. Such glycoproteins are responsible for organ rejection and, in the case of blood cells, blood typing.

Highlights Glycolysis

1. Glycolysis is a metabolic pathway for the breakdown (catabolism) of glucose and related sugars. The pathway requires two ATPs to start the process and generates 4 ATPs (for a net of two ATPs) per glucose. Also generated during glycolysis are two NADHs.
2. The two NADHs produced in glycolysis are a factor in determining which pathways is taken after pyruvate is produced in glycolysis.
3. Hexokinase (need to know) is an enzyme that catalyzes the first step in glycolysis. It uses an ATP to put a phosphate onto glucose, making glucose-6-phosphate (G6P) and ADP.
4. G6P is converted to fructose-6-phosphate (F6P) in the next step of the pathways. Hexokinase is also able to convert fructose to F6P (using ATP) in a reaction very similar to that for glucose. This means that fructose too can readily enter the glycolysis pathway. Other sugars have other ways of entering.
5. Conversion of F6P to fructose-1,6-bisphosphate (F1,6BP - need to know) is catalyzed by the enzyme phosphofructokinase (PFK) (need to know). This reaction also requires ATP and is an irreversible reaction. ATP is an allosteric effector. High levels of ATP inhibit the enzyme. Low levels stimulate the enzyme. This is consistent with the energy needs of the cell - when ATP is low, cells need glycolysis to run, so PFK is turned ON. When ATP is high, cells don't need glycolysis to run, so PFK is turned OFF. PFK is a major control point for glycolysis because it stops the pathway for entry of either glucose or fructose.
6. In the next step of glycolysis, the six carbon F1,6BP is split into two three carbon pieces. The ΔG for this reaction is very positive, meaning that there is an energy barrier to get over. The cell accomplishes this by increasing the amount of reactant (F1,6BP) and decreasing the amount of products (G3P and DHAP). This has the effect of making the \ln term in the ΔG equation more negative. The phenomenon is called pushing (increasing reactants) and pulling (removing products).

7. The two three carbon pieces are then converted into the same form - glyceraldehyde-3-phosphate (G3P). The enzyme doing the catalysis, triose phosphate isomerase, is one of the most efficient enzymes on earth.
8. Reaction 6 of glycolysis involves the only oxidation. The enzyme responsible is glyceraldehyde-3-phosphate dehydrogenase (G3PDH - need to know). In the reaction, the aldehyde of G3P is converted to an acid group, which is subsequently linked to a phosphate. Note that the energy of the oxidation provides the necessary energy to put the phosphate on. ATP is not required.
9. In reaction 7, ATP is generated. Since there are two three carbon molecules per six carbon glucose, two ATPs are produced per starting glucose. This reaction is referred to as a substrate level phosphorylation (ATP being made directly from ADP by transfer of a phosphate from another molecule with phosphate). Substrate level phosphorylation is one of three types of phosphorylation in cells. We will talk more about the others later.
10. Reaction 8 is a simple isomerization. Reaction nine involves removal of a water molecule from each three carbon intermediate to form the high energy molecule called phosphoenolpyruvate (PEP).
11. Reaction 10 is the "big bang" reaction of glycolysis. It produces another ATP for each PEP (by substrate level phosphorylation) and in turn, each PEP is converted to pyruvate, the end product of glycolysis. The enzyme, pyruvate kinase, is an important one, as it provides yet another control point for glycolysis. Pyruvate kinase is controlled by both allosteric and covalent modifications. This reaction is VERY energetically favorable and helps to "pull" earlier reactions that are not so favorable.
12. Glycolysis is regulated by three enzymes - hexokinase (inhibited by G6P), phosphofructokinase (inhibited by ATP), and pyruvate kinase (inhibited by ATP). I will say more about regulation later.