Homework

1. Why are monosaccharides appropriately named “*carbo hydrates*”?

Because the chemical formula can be written as (CH2O) n.

1. Why are monosaccharides soluble in water but not in nonpolar solvents?

Monosaccharides are rich in hydroxyl group. So, it is easy for monosaccharides to form hydrogen bonds with water molecules.

1. The word “chiral” is derived from the Greek word meaning “hand”. How does this relate to the structure of carbohydrates?

Carbohydrates contain chiral carbon atoms (except dihydroxyacetone) which have four different adjacent groups. These carbon atoms make carbohydrates be the chiral molecules.

1. How many D isomers would an aldopentose have? How many total isomers?

D isomers: 22=4 Total isomers: 23=8

1. What is a possible explanation for the observation that most of the hexoses found in living organisms are D isomers?

*Esters of proteinogenic amino acids efficiently catalyse the formation of erythrose and threose under potentially prebiotic conditions in the highest yields and enantioselectivities yet reported. Remarkably while esters of (L)-proline yield (L)-tetroses, esters of (L)-leucine, (L)-alanine and (L)-valine generate (D)-tetroses, offering the potential to account for the link between natural (L)-amino acids and natural (D)-sugars. The effect of pH and NaCl on the yields and enantioselectivities was also investigated and was shown to be significant, with the optimal enantioselectivities occurring at pH 7.*

1]Laurence Burroughs,a Paul A. Clarke,\*a Henrietta Forintos,etc.Asymmetric organocatalytic formation of protected and unprotected tetroses under potentially prebiotic conditions[J].Organic & Biomolecular Chemistry,2012,:.

1. In an aqueous solution of D-glucose, why will there always be a very small amount of the liner form of the monosaccharide?

The transformation of liner form and cyclic form is a process which tend to reach the equilibrium. In thermodynamic, cyclic form of sugars are more stable. So, there always small amount of the liner form of the monosaccharide.

1. Does the discussion on conformations of cyclic forms of monosaccharides suggest an explanation for why the more common anomer of D-fructofuranose is the β anomer?

The β anomer of cyclic D-fructofuranose contains more flat bond, so it is more stable.

1. How many D isomers would a cyclized aldopentose have? How many total isomers?

D isomers: 23=8 Total isomers: 24=16

1. What are some of the biologically more important monosaccharide derivatives?

N-acetyl-glucosamine, glucose-6-phosphate, rhamnose.

1. Why is phosphorylation of sugars beneficial to a cell?

Phosphorylated sugars cannot go out of cell. And formation of phosphorylated sugars is benefit to transport sugars into cell because of the decrease of sugar concentration.

1. What is reduced and what is oxidized in the reaction between a monosaccharide and a ferric ion?

Monosaccharide is oxidized and ferric ion is reduced.

1. Be able to draw and give the complete name of the disaccharides commonly known as maltose, lactose, and sucrose. Which of these is/are reducing sugars?

Reducing sugar: maltose, lactose.

1. What are the structural and functional differences between homopolysaccharides and heteropolysaccharides?

Homopolysaccharides are constructed by only one kind of monosaccharide, whereas heteropolysaccharides are constructed by multiple kinds of monosaccharide.

Function:

Homopolysaccharide: Storage of sugar, structural function (cellulose, chitin)

Heteropolysaccharide: Structure function (bacteria cell wall, extracellular matrix), signal transduction.

1. Why are *homo*polysaccharides not useful as informational molecules?

Homopolysaccharides are constructed by only one kind of monosaccharide. So, they are not diversity in sequence.

1. Suppose you had three polysaccharides, amylose, amylopection, and glycogen, each with the same number of monosaccharide subunits. Which would be degraded the fastest, assuming that the enzymes acting to degrade the polysaccharides all worked at the same rate?

Glycogen.

1. What are the similarities and differences between cellulose and chitin?

Similarities: β1→4 glycosidic bonds, homopolysaccharide, structural polysaccharide.

Differences: monosaccharide unit (cellulose: glucose, chitin: N-acetyl-glucosamine.)

1. What are the most important noncovalent bonds or interactions in cellulose?

Hydrogen bonds.

1. How does lysozyme act as a first defense against bacterial infection? How does penicillin combat bacterial infections?

Lysozyme can break β1→4 glycosidic bonds in peptidoglycan to degrade bacteria cell wall.

Penicillin can inhibit the synthesis of peptidoglycan so that bacteria cannot form cell wall regularly. Thus, bacteria become sensitive surrounding osmatic pressure.

1. How does heparin work to inhibit blood coagulation?

(1) Help antithrombin to interact with Factor Xa.

(2) Hep AT to interact with thrombin.

1. One of the distinctions between proteoglycans and glycoproteins is entirely relative. The second half of the name usually indicates the predominant species. So, by this, what is the difference between proteoglycans and glycoproteins?

Proteoglycans is mainly constructed by glycan moiety, whereas glycoprotein is mainly construct by protein moiety.

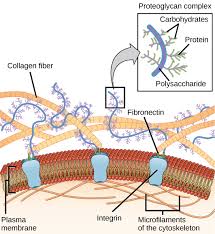
1. How does the R-group of Ser make it a good amino acid for connecting to a carbohydrate moiety?

Ser contains hydroxyl as its R group which can condensation with hemiacetal hydroxyl group of carbohydrate.

1. If a proteoglycan aggregate is compared to an evergreen tree, with hyaluronate as the “trunk,” what compound would be the “needles” on this tree? What role do the core proteins play?

Needles: Aggrecan core proteins, keratan sulfate, chondroitin sulfate.

Core protein: It is, the core which connect both hyaluronate and other kinds of glycosaminoglycan, like the “bough” of the evergreen tree.

1. What is the relationship among glycosaminoglycans, proteoglycans, fibrous proteins, integrins, adhesion proteins, and the extracellular matrix? It may be helpful to diagram the cellular locations of each of these components.
2. How are the functions of glycoproteins different from those of glycosaminoglycans?

Glycosaminoglycans: structural functions, signal transduction.

Glycoproteins: immune functions (immunoglobulin), transduction of information in long distance (hormones), cell-cell recognize etc.

1. What types of linkages connect oligosaccharides to proteins?

O-linked bonds and N-linked bonds.

1. What kinds of biologically important information are encoded by the oligosaccharide portions of glycoproteins?

Blood types, distribution of lysosome proteins, epitope of antigen, cell identity.

1. How does the addition of carbohydrate moieties alter the chemistry of glycoproteins and glycolipids?
2. How do glycolipids and lipopolysaccharides differ?

Glycolipids are mainly constructed by lipid moiety, whereas lipopolysaccharides are constructed by polysaccharide moiety.

Glycolipids presence on many kinds of cell’s membrane. Lipopolysaccharides, is also called endotoxin, only presence in Gram-negative bacteria cell wall.

1. How can so much distinguishing information be packed into an oligosaccharide of comparatively few monosaccharide units?

(1) Monosaccharide is highly diverse.

(2) The way to link each monosaccharide are diverse.

1. Why do people of blood type O tend to have gastric ulcers more often than do people of blood type A or B?

Because this bacterium cause ulcers by interaction between lectin and the Leb oligosaccharide. People of blood type O contain explored Leb oligosaccharide.

Do You Know the Facts?

1. Which of the following is not a characteristic of carbohydrates in cells? D

A. They serve as energy stores in plants and animals.

B. They are major structural components of plant tissues.

C. They act as binding sites for proteins.

D. They are organic catalysts.

E. They play a role in cell-cell recognition.

2. Which of the following contributes to the structural rigidity of cellulose? A

A. Adjacent glucose polymers are stabilized by hydrogen bonding.

B. Glucose residues are joined by (α1—4) linkages.

C. Cellulose is a highly branched molecule.

D. The conformation of the glucose polymer is a coiled structure.

E. Adjacent polymers are covalently linked by short peptides.

3. Which of the following is an epimer of glucose? B

A. Talose

B. Idose

C. Gulose

D. Altrose

E. Allose

4. Why are sugars usually found as phosphorylated derivatives in cells? B

A. Phosphorylated sugars are important in regulating cellular pH.

B. Unphosphorylated sugars can be transported across cell membranes.

C. Unphosphorylated sugars are rapidly degraded by cellular enzymes.

D. Phosphorylated sugars encode genetic information.

E. None of the above is a correct explanation.

5. Which of the following disaccharides could be extended to form a cellulose polymer? E

A. Sucrose

B. Trehalose

C. Maltose

D. Lactose

E. None of the above.

6. Which of the following is a heteropolysaccharide? B

A. Glycogen

B. Hyaluronate

C. Starch

D. Cellulose

E. Chitin