**Carbohydrates I** Assigned reading in Horton: 8.1-8.4. Nelson 5e: 7.1

**Key Terms:**

* **aldose**
* **ketose**
* **epimers**
* **hemiacetal**
* **anomeric carbon**
* **Haworth Representation**

**Carbohydrates are**:

1. The primary energy reservoir in biosphere.
2. Biosynthetic precursors to amino acids and nucleic acids.
3. Targeting of proteins for trafficking within the cell.
4. Structural and mechanical components.

* Cell walls in plants



* Cell walls in bacteria

**Structural Hierarchy:**

1. Monosaccharides: cannot be hydrolyzed to simpler sugars.
2. Oligosaccharides: 'a few' covalently linked monosaccharides.
3. Polysaccharides: 'many' covalently linked monosaccharides.

**Monosaccharides:** All carbons in monosaccharides are 'hydrated' -hence the name *carbohydrate (general formula (CH2O)N)*

1. The simplest monosaccharides contain three carbons:
2. When the C=O group is at the 2nd position it's called an **ketose**.
3. When the C=O group is at the very end it's an **aldose**.
4. Note that the aldose, glyceraldehyde, has a chiral center and therefore exists in D and L forms, or mirror images of each other. The D-form is the "root" compound for all other naturally occurring aldoses.
5. Additional hydrated carbons (HO-C-H) are added just below the aldehyde or ketone group. Therefore, the chiral center of D-glyceraldehyde is preserved. The added carbon generates a new chiral center. The two different molecules generated by the addition of another carbon are called ***epimers*** because the differ in only *one* chiral center. For example, the addition of a CH2OH unit to D-glyceraldehyde gives the following two epimers: erythrose and threose.

**Ketoses:**



**Important sugars to remember are:**

|  |  |
| --- | --- |
| **Aldose** | **Ketose** |
| **Glyceraldehyde** (C3) [Important in energy metabolism] | **Fructose** (C6)  [Important in metabolism] |
| **Ribose** (C5) [Building block of DNA and RNA] |
| **Glucose** (C6) [Energy metabolism and structural elements] |

**Ring formation:**



In general, alcohols can attack the C=O group in sugars to form *hemiacetals*. Since sugars have OH groups, they can form hemiacetals by an intramolecular reaction, forming closed rings.

Only long (>C4) saccharides can form internal hemiacetals, giving closed rings (Includes ribose, glucose, fructose). No atoms are lost or gained in this reaction!

**Ring Formation in Glucose**

1. Six membered ring created by forming a bond between C1 and O5 (most stable ring size).

2. This form is called pyranose, *i.e.* glucopyranose after the organic compound, pyran.



3. The C1 carbon becomes chiral and is called the ***anomeric*** carbon

4. The new OH group (on C1) can exist in either the  or β form.

5. The α and β forms can readily inter-convert via the linear intermediate.



**C5 Aldose: Ribose**



1. Formation of a 5 membered ring can occur by forming a bond between C1 and O4.

2. The cyclic form is called a furanose (i.e. ribofuranose) after the organic compound, furan.



**C6 Ketose: Fructose**

Although this is a 6-carbon sugar, because it is a ketose a five membered ring is formed.

This is also called a furanose (*i.e.* fructo-furanose).

**How to identify the anomeric carbon:**



**Presentation of structures:** Fischer, Haworth, Reduced Haworth Representations.

i) tip clockwise, ii) move –O- to back, iii) down = down, up = up.