**Concept Map:**

1. Carbohydrates
2. Lipids & Membranes
3. Metabolism - pathways
* Glycolysis
* Electron transport
* ATP synthesis
* Anaerobic metabolism (fermentation)
1. Cholesterol metabolism & cholesterol control
2. Cell Signaling and breast cancer.

**Introduction to Carbohydrates:**

**Monosaccharides:** All carbons in monosaccharides are 'hydrated' -hence the name *carbohydrate (general formula (CH2O)N). Each carbon is bound to one oxygen. The first or the second carbon is a C=O.*

1. The simplest monosaccharides contain three carbons (dihydroxyacetone, glyceraldehydes)
2. When the C=O group is at the 2nd position it's called an **ketose**, because the functional group is a ketone, e.g. dihydroxyacetone.
3. When the C=O group is at the very beginning it's an **aldose**, because the functional group is an aldehyde, e.g. glyceraldehydes.
4. Additional hydrated carbons (HO-C-H) are added just below the aldehyde or ketone group to make longer carbohydrates.
5. The added carbon generates a new chiral center. Each aldose differs from its neighbor by the configuration (orientation of –OH) of at least one of the carbon.

**Ketoses:** The addition of three (HO-C-H) units to dihydroxyacetone gives the 6 carbon ketose - fructose, an important sugar in metabolism.

* **Aldose – C=O on carbon one.**
* **Ketose – C=O on carbon two**
* **All other carbons have –OH group.**

**Ring Formation in Glucose**

1. Six membered ring created by forming a bond between C1 and O5. Most stable state.

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

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

 α-down β-up

**Ring formation in Ribose -** Formation of a 5 membered ring can occur by forming a bond between C1 and O4.

**C6 Ketose: Fructose -** Although this is a 6-carbon sugar, because it is a ketose a five membered ring is formed when it forms a ring.



**Disaccharides:** Linkage of the anomeric carbon of one monosaccharide to the OH of another monosaccharide via a *condensation* reaction.

* The bond is termed a ***glycosidic bond.***
* ***At least on anomeric carbon participates in forming the bond.***

**Lactose** (milk sugar):

Major sugar in mammalian milk.

* Infants produce lactase to hydrolyze the disaccharide to monosaccharides, the released glucose and galactose are sued
* Some adults have low levels of lactase. This leads to *lactose intolerance*. The ingested lactose is fermented by bacteria in the large intestine, producing uncomfortable volumes of CO2.

**Sucrose** (table sugar): The anomeric carbon of glucose forms a glycosidic bond to the anomeric carbon of fructose.

**C. Polysaccharides:** Many monosaccharides linked by glycosidic bonds. Most poly-saccharides are polymers of either glucose, or modified glucose.

**Short-hand nomenclature**: In the case of homo-polymers, the short-hand notation is to simply describe the linkage between the glucose units: both the conformation of the anomeric carbon and the carbons participating in the glycosidic bond, i.e. β(1-4).

**Energy Storage Polysaccharides:** Glucose is released when required.

1. Starch [plants] (mixture of amylose and amylopectin).

1. amylose = α (1-4) glucose. .

2. Amylopectin [plants] = amylose plus α (1-6) branches.

3. Glycogen [animals] =

1. more highly branched than amylopectin.

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**Structural Polysaccharides**

1. Cellulose: Structural polysaccharide of plants.

1. β 1-4 glucose, can't be digested by mammalian enzymes.
2. Digested by symbiotic microorganisms (such as those in termites)



2. Bacterial Cell Walls (**Peptidoglycan**)

1. Polysaccharide chains of alternating N-acetylglucose amine (NAG) and N-acetylmuraminc acid (NAM)
2. Muramic acid on NAM linked to a small peptide (L-Ala D-Gln L-Lys D-Ala).
3. NAM peptide chains are crosslinked with penta(5)glycine bridges that extend off of terminal Ala and join to L-Lys sidechain on adjacent chain, forming a tough **crosslinked** cell wall.

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**Mechanism of Action of Penicillin:**

* Penicillin inhibits enzymes that are responsible for crosslinking the Gly5 chain to alanine (circled on diagram).
* The crosslinking of the cell wall is broken, making the bacteria fragile to breakage.
* Inhibition is by formation of a chemical bond between penicillin and the enzyme (covalent inhibitor). This type of inhibition is not the same as competitive inhibition because: i) the penicillin forms a covalent bond with the enzyme, ii) penicillin is modified by the reaction, iii) the reaction is essentially irreversible.

**Penicillin Resistance**: Bacterial produce a protein that degrades penicillin (β-lactamase). This is a common antibiotic resistance gene that is used on plasmids. The transformed bacterial are resistant to penicillin!