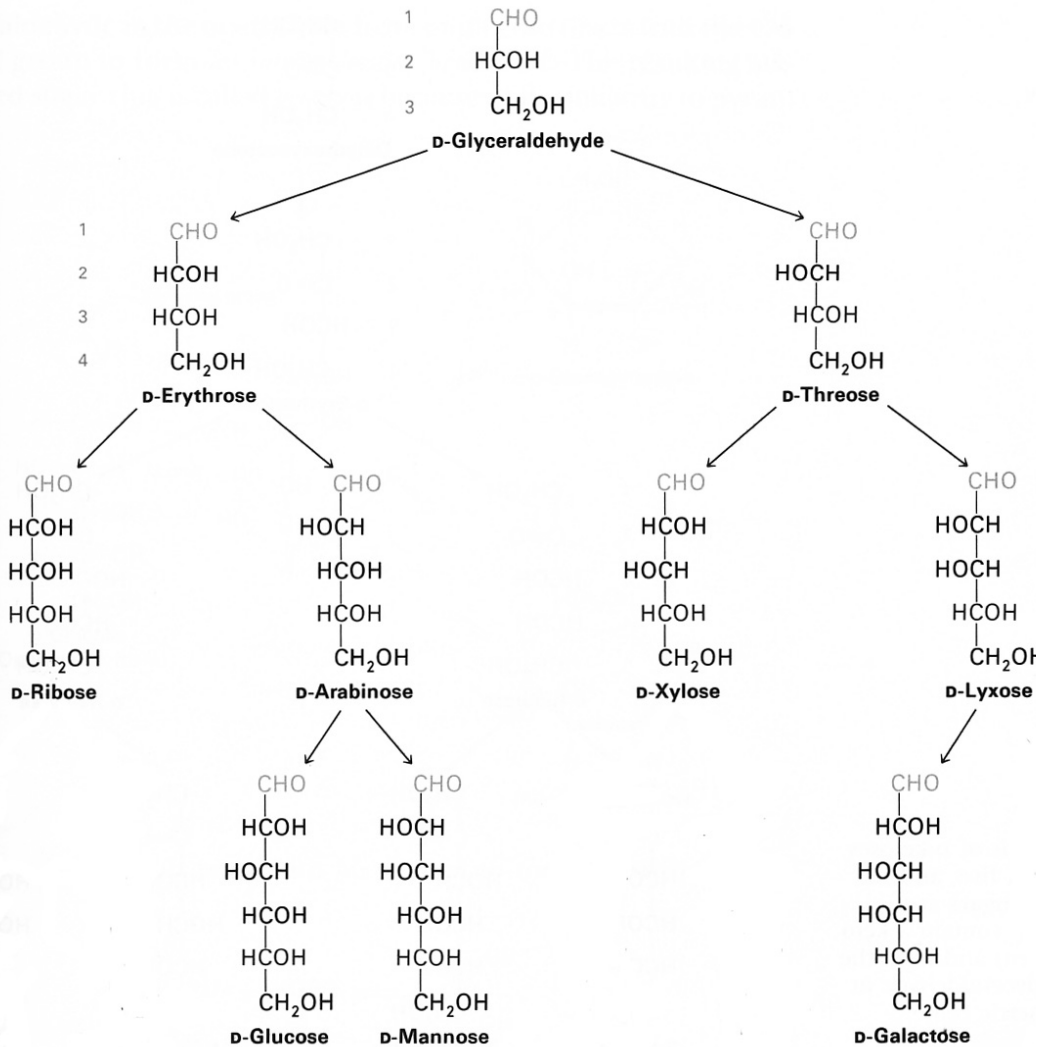


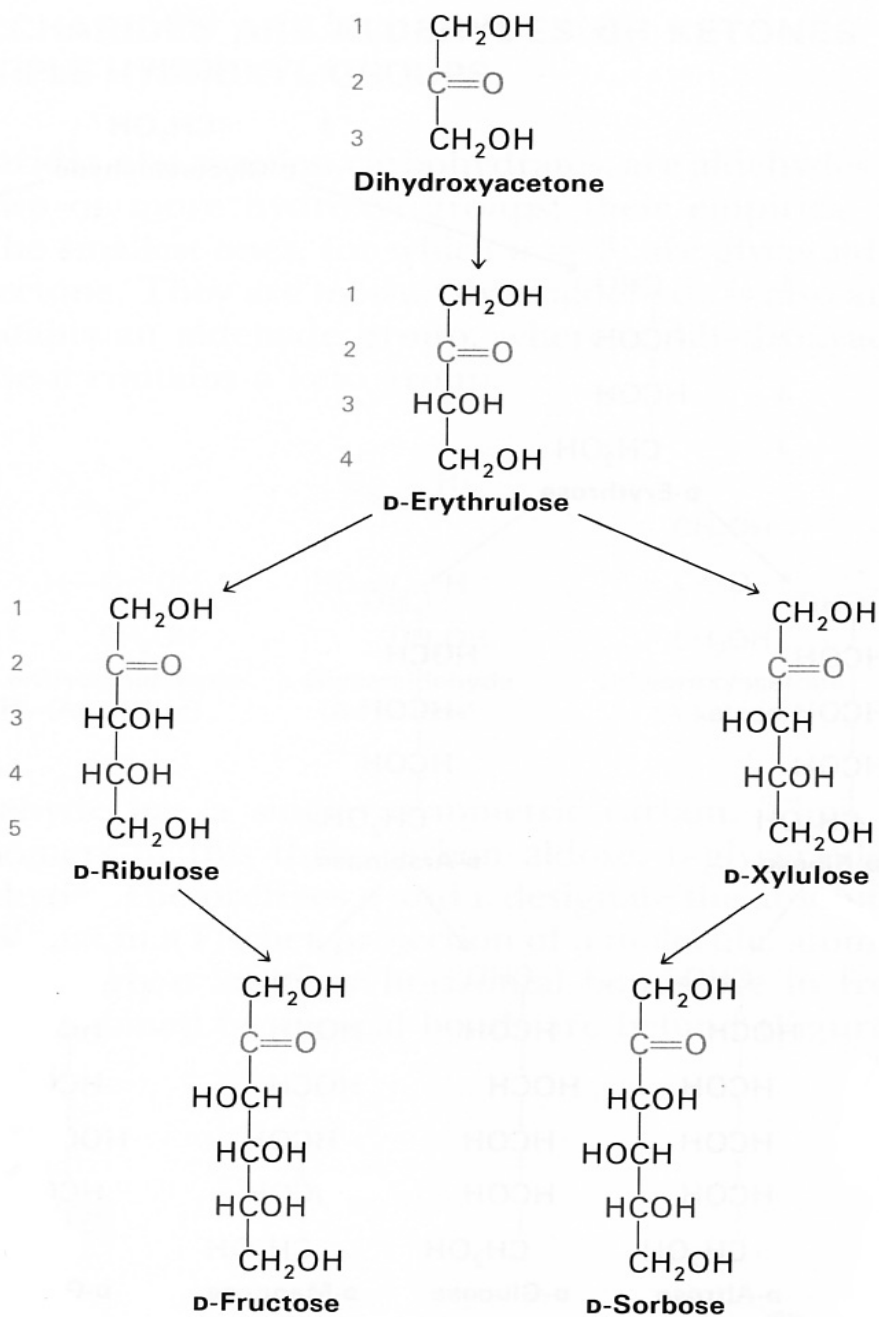
ANSC 619
PHYSIOLOGICAL CHEMISTRY OF LIVESTOCK SPECIES
Carbohydrate Chemistry

I. General structures



A. D-Aldoses

1. All monosaccharides are aldehydes or ketones with multiple hydroxyl groups (i.e., alcohol groups).
2. Smallest is D-glyceraldehyde (as in glyceraldehyde-3-phosphate in glycolysis).
3. Nutritionally most important is D-glucose.
4. L-forms are *mirror images*.

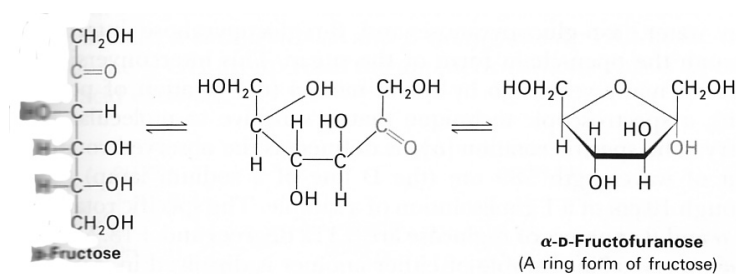
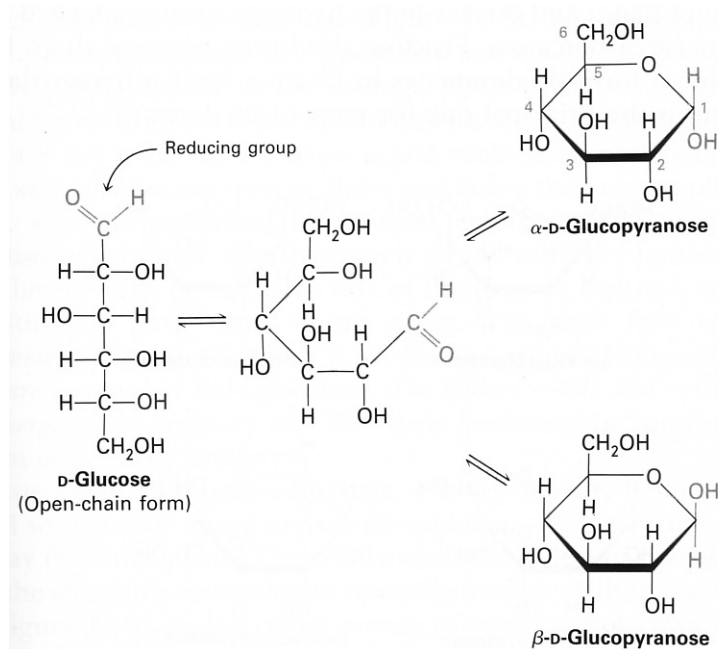


B. D-Ketoses

1. Smallest is D-dihydroxyacetone (as in dihydroxyacetone-phosphate).
2. Nutritionally most important is D-fructose.
3. Free aldehydes and ketones are *reducing sugars*. In the presence of heat and OH^- they reduce cations.

C. Formation of ring structures

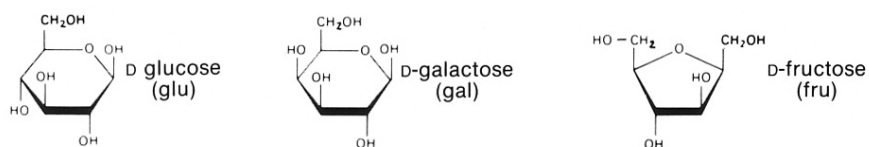
1. Six-sided *pyranoses* form when the free aldehyde end of a hexose reacts with one of the C-5 alcohol group to form a hemiacetal.
2. Five-sided *furanoses* form when the C-2 keto group of a hexose reacts with one of the C-5 alcohol group to form another hemiacetal.



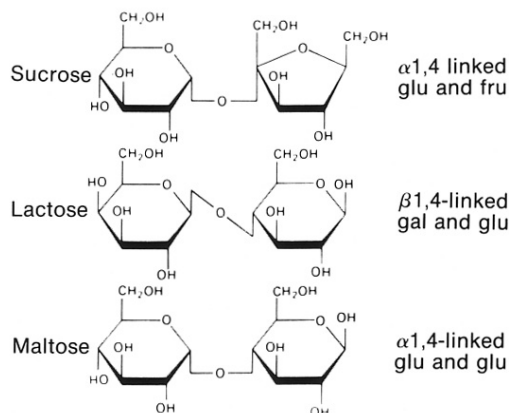
D. Monosaccharides and dissacharides

1. Monosaccharides have free reducing ends.
2. Dissacharides can have free reducing ends, and are linked by α -1,4, α -1,2 or β -1,4-O-glycosidic bonds.

MONOSACCHARIDES

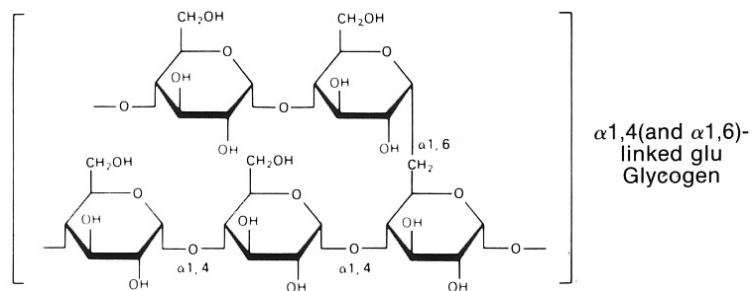
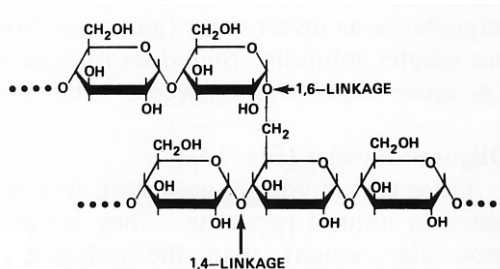
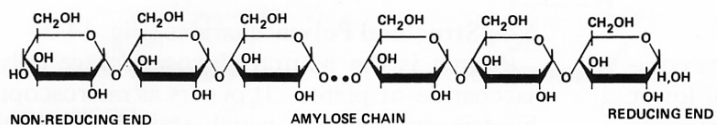


DISACCHARIDES

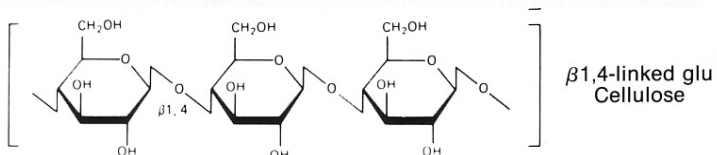
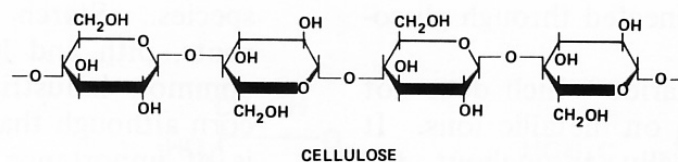


E. Nonstructural polysaccharides

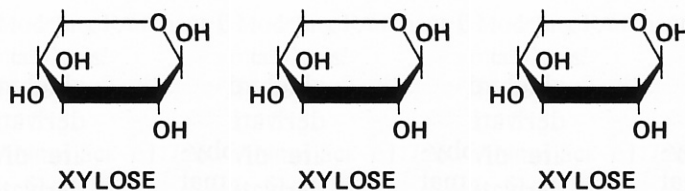
1. Amylose – the linear subunit of starch and glycogen. Has only α -1,4 linkages. **Soluble.**
2. Amylopectin – the branched subunit of some starches and glycogen. Contains both α -1,4 and α -1,6 linkages. **Soluble.**
3. Starch – linear and branched
4. Glycogen – only branched

**F. Structural polysaccharides**

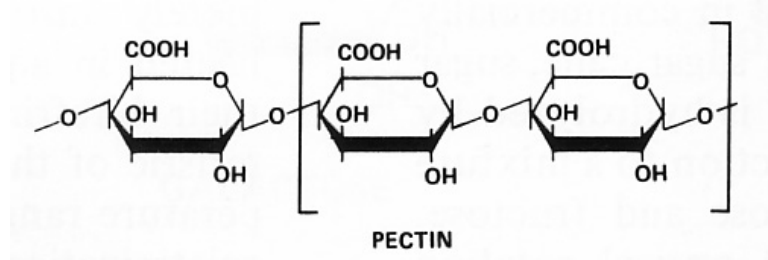
1. Cellulose – Linear polymers of glucose in β -1,4 linkage.

Insoluble.

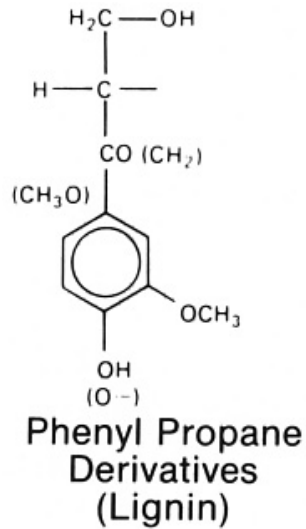
2. Hemicellulose (xylans) – linear/branched polymers of *xylose* in β -1-4 linkages.

Insoluble.

3. Pectins – linear polymers of *galacturonic acid* in 1-4 linkages that are neither α or β . **Soluble.**

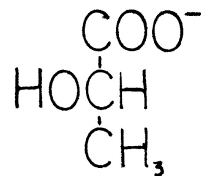


4. Lignin – highly branched polymer of substituted phenylpropanes. **Insoluble.**

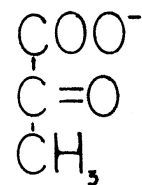


G. Structures to memorize:

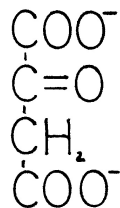
Glucose (open structure and ring structure), indicated above



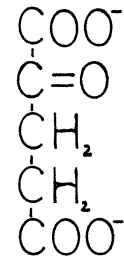
Lactate (end product of glycolysis)



Pyruvate (= lactate – 2H)



Oxaloacetate (= pyruvate + CO_2)



α -ketoglutarate (= oxaloacetate + CH_2)

II. Dietary sources of carbohydrates

| Carbohydrate | Sources | Structure and properties |
|--------------------------|---|---|
| D-Glucose (dextrose) | Fruit; traces in most plant foods; honey; maple sugar | Water-soluble monosaccharide |
| D-Fructose | Fruit; traces in most plant foods; honey; maple sugar | Water-soluble monosaccharide |
| D-Galactose | Component of lactose | Water-soluble monosaccharide |
| Sucrose | Cane sugar; beet sugar; fruits; maple sugar | Water-soluble disaccharide; α -1,2-linked glu-fru |
| Lactose | Milk; dairy products | Water-soluble disaccharide; (β -1,4-linked gal-glu |
| Maltose | Sprouted grain; produced during digestion of starches | Water-soluble disaccharide; α -1,4-linked glu-glu |
| Raffinose | Soybean and cottonseed meals; sugar beets | Water-soluble trisaccharide; α -1,6, α -1,2-linked gal-glu-fru |
| Stachynose | Soybeans | Water-soluble tetrasaccharide; α -1,6, a-1,6, α -1,2-linked gal-gal-glu-fru |
| Amylose | Starchy plants; grains | Water-soluble linear polymer of glucose; α -1,4-linked |
| Amylopectin (starch) | Starchy plants; grains; thickener in processed foods | Water-soluble branched polymer of glucose; α -1,4- and a-1,6-linked |
| Glycogen (animal starch) | Liver; muscle | Water-soluble branched polymer of glucose; α -1,4- and α -1,6-linked |
| Invert sugar | Processed foods | Hydrolyzed sugar (much |

| | | |
|-------------------------|------------------------------|--|
| Corn syrup | Processed foods | sweeter than sugar) |
| Pectins | Fruits | Hydrolyzed starch (i.e., glucose) |
| Lignin | Plant cell walls | Water-soluble linear polymers of galacturonic acids and/or modified galacturonic acid; β -1,4-linked |
| Cellulose | Plant cell walls; wheat bran | Insoluble highly branched polymer of substituted phenylpropanes; not a carbohydrate |
| Hemicellulose | All land plants | Insoluble linear polymer of glucose; β -1,4-linked |
| 1. Xylan (cellulosan) | | Insoluble linear/branched polymer of xylose; β -1,4-linked; may contain glucuronic acid. |
| 2. Amorphous encrusting | All land plants | Insoluble ester linkage of xylose to lignin |