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Chemistry of Honey

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Honey

- 15-18% water
- Viscous, sometimes solid
- Various colors
- Various flavors, aromas

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Nectar

- 80% water
- Colorless
- Slightly sweet – fructose, glucose, other complex sugars
- Flower type determines aroma and other constituents
- Bees collect from one flower type at a time.

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Carbohydrates

- One of 3 principal classes of food along with lipids and proteins
- Named because some (but not all) have empirical formula $(CH_2O)_n$ "Hydrates of carbon"

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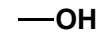
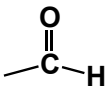
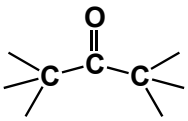
Carbohydrates

- Hydroxyl
- Aldehyde
- Ketone
- Polyhydroxy aldehydes or ketones or their polymers







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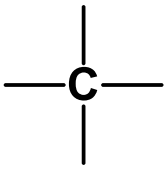
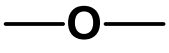
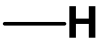
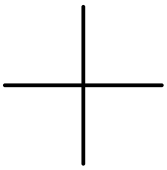
Carbon, Hydrogen, and Oxygen









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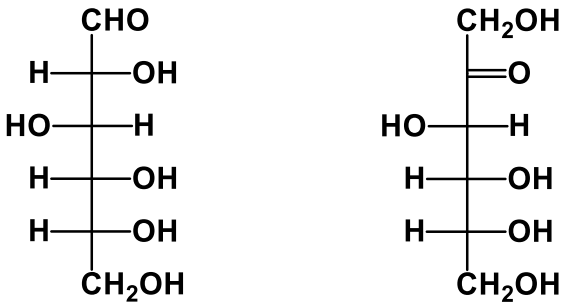
Honey Monosaccharides

Fischer Projections



Glucose Fructose

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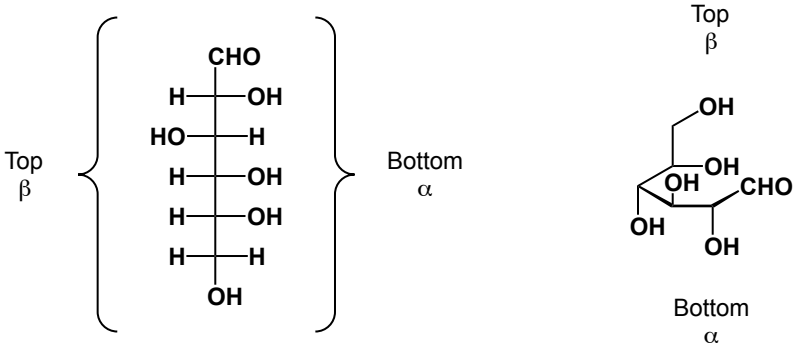
Haworth Projections

- 3-D depiction of monosaccharides
- Carbon chain is tipped on its side



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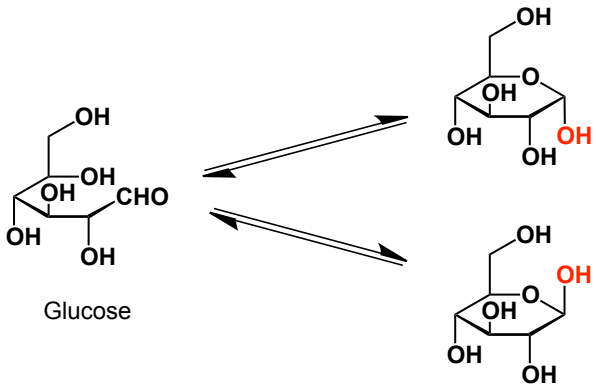
Glucose Hemiacetals



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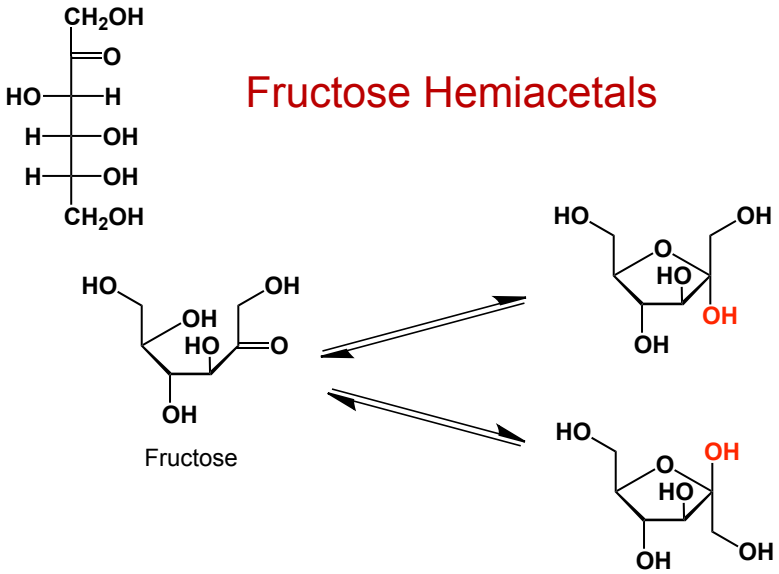
Fructose Hemiacetals



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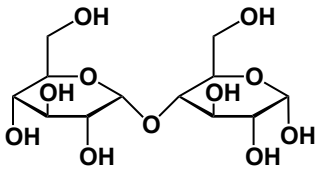
Disaccharides

- Two monosaccharides joined by a glycosidic bond
- α-Maltose (from the hydrolysis of starch)



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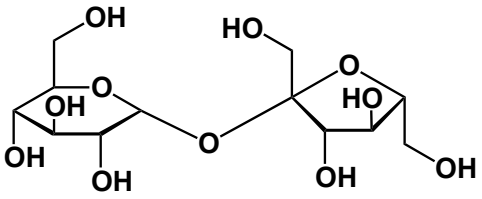
Sucrose



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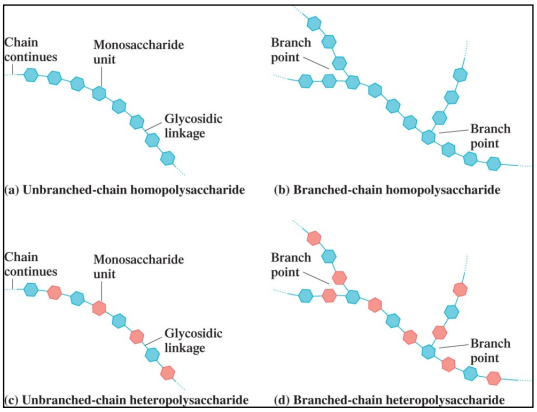
Polysaccharides

- Many linked monosaccharide units
- Linear or branched, homogeneous or heterogeneous



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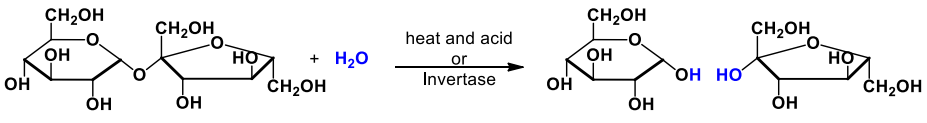
Hydrolysis of Carbohydrates

- Breaking with water
- Requires heat and corrosive catalysts OR…
- Milder temperatures and enzymes



Sucrose Glucose Fructose

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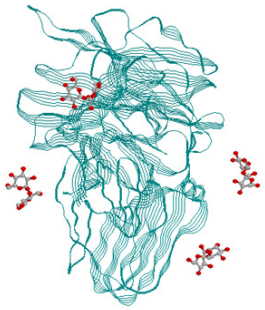
Enzymes

Enzymes

- An organic compounds that act as a catalysts for a biochemical reactions
- As catalysts, they are not consumed in the reactions
- The most effective catalysts known
- Most are globular proteins



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Honey Ingredients

- Carbohydrates (sugars)
- Vitamins and Minerals
- Amino Acids
- Enzymes
- Growth Hormones
- Organic Acids
- Pollen
- Fragrance and Flavor Compounds

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Converting Nectar to Honey

- Nectar is very dilute, 80% water
- Forager adds sugar hydrolyzing enzymes to make complex sugars digestible
- Foragers transfer nectar to house bees, more enzymes added. Continues as nectar passed amongst the house bees.

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- House bees concentrate nectar using proboscis and crop
- Place in empty cells in brood nest for 1-3 days to ~20% moisture.
- Moved to comb margins, honey supers for further drying.
- Capped when <18% water

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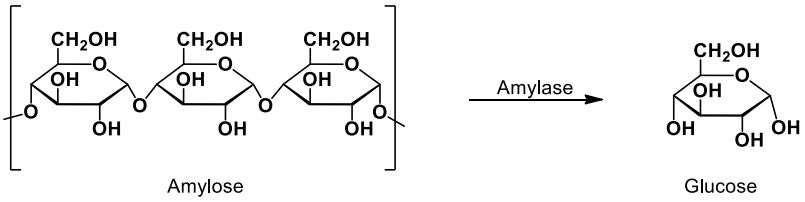
Enzymes in Honey

- Invertase
- Amylase
- Glucose oxidase
- Catalase

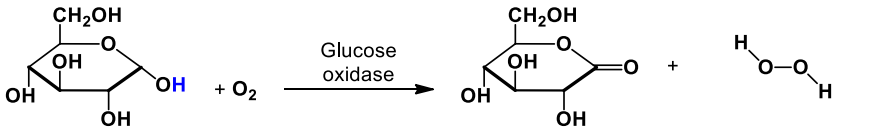
Amylase



Amylose

Glucose

Glucose Oxidase



Glucose | Gluconic acid | Hydrogen peroxide

Catalase

$$2\ H_2O_2 \xrightarrow{\text{catalase}} 2\ H_2O + O_2$$

Crystallization

- More likely when there is more glucose than fructose
- May lead to fermentation

Heating Honey

- Pasteurization
- Carmelization
- Maillard Reaction

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Carmelization

- Fragmentation reactions
- Unsaturated polymers
- Dehydration and condensation reactions
- Glucose isomerizes to fructose

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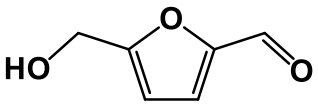
Hydroxymethylfurfural (HMF)

- Product of heating fructose
- Toxic to honey bees
- Potentially a component of high fructose corn syrup



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Maillard Reaction

- Amino acids react with monosaccharides

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