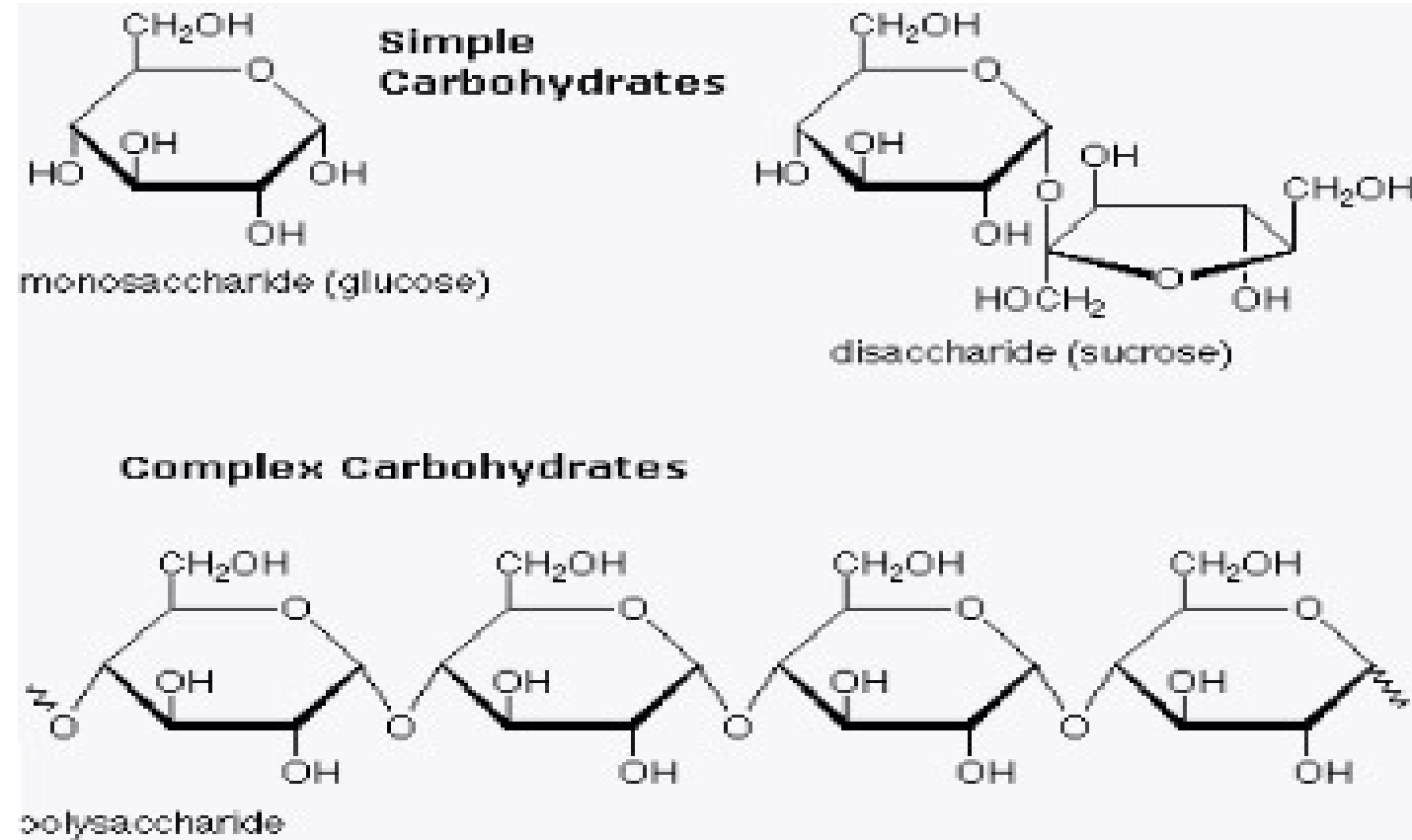


# Carbohydrates

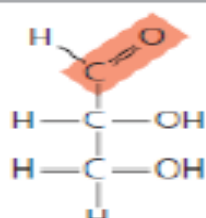
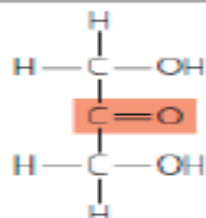
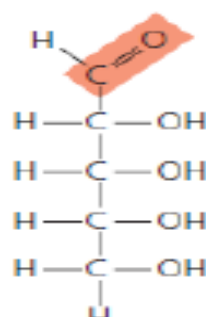
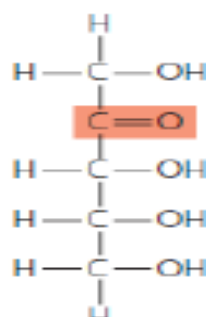
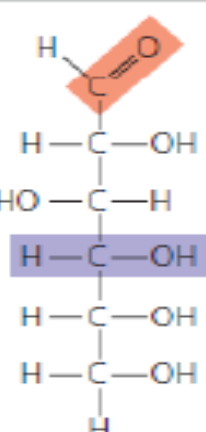
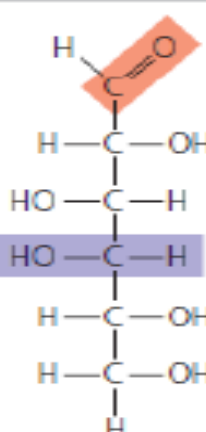
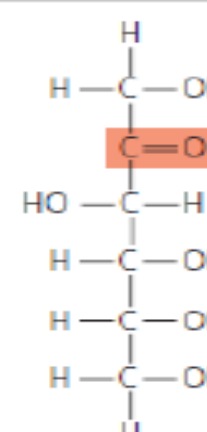


- ✓ Carbohydrates include both **sugars** and **polymers** of sugars
- ✓ Simplest form (**Monosaccharides**)
- ✓ Disaccharides (formed by **two** monosaccharides)



- ✓ Carbohydrates also include macromolecules called polysaccharides

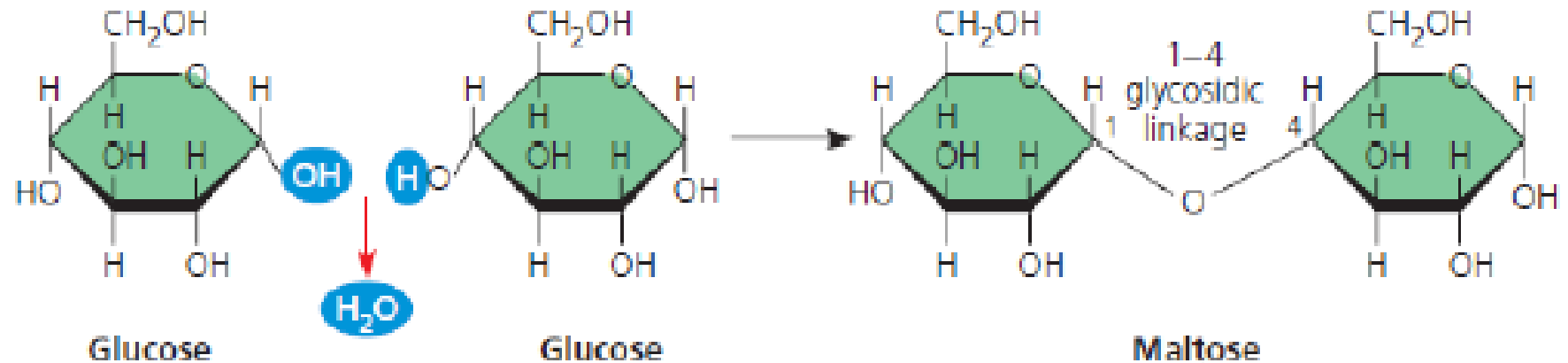
- Monosaccharides (from the Greek monos, **single**, and sacchar, **sugar**)
- monosaccharide, is of **central importance** in the chemistry of life
- Empirical formula unit **CH<sub>2</sub>O**. Glucose (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>)(multiples of 6)

Aldoses (Aldehyde Sugars) Carbonyl group at end of carbon skeleton		Ketoses (Ketone Sugars) Carbonyl group within carbon skeleton	
Trioses: 3-carbon sugars (C <sub>3</sub> H <sub>6</sub> O <sub>3</sub> )			
			
<b>Glyceraldehyde</b> An initial breakdown product of glucose	<b>Dihydroxyacetone</b> An initial breakdown product of glucose		
Pentoses: 5-carbon sugars (C <sub>5</sub> H <sub>10</sub> O <sub>5</sub> )			
			
<b>Ribose</b> A component of RNA	<b>Ribulose</b> An intermediate in photosynthesis		
Hexoses: 6-carbon sugars (C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> )			
			
<b>Glucose</b> Energy sources for organisms	<b>Galactose</b> Energy sources for organisms	<b>Fructose</b> An energy source for organisms	

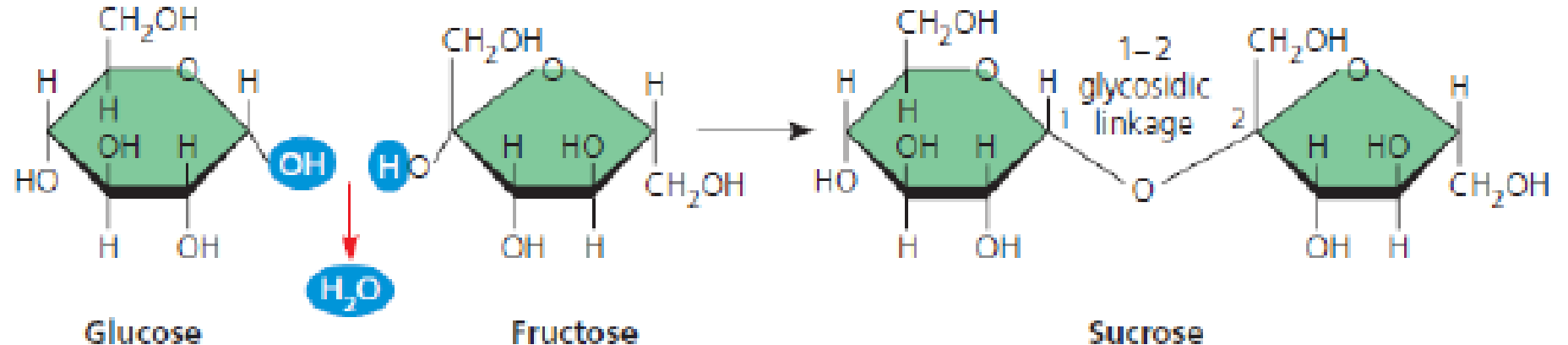
## Bonds forming Glycosidic linkages

## Bond Breaking: Hydrolysis, Dehydration

(a) **Dehydration reaction in the synthesis of maltose.** The bonding of two glucose units forms maltose. The glycosidic linkage joins the number 1 carbon of one glucose to the number 4 carbon of the second glucose. Joining the glucose monomers in a different way would result in a different disaccharide.



(b) **Dehydration reaction in the synthesis of sucrose.** Sucrose is a disaccharide formed from glucose and fructose. Notice that fructose, though a hexose like glucose, forms a five-sided ring.

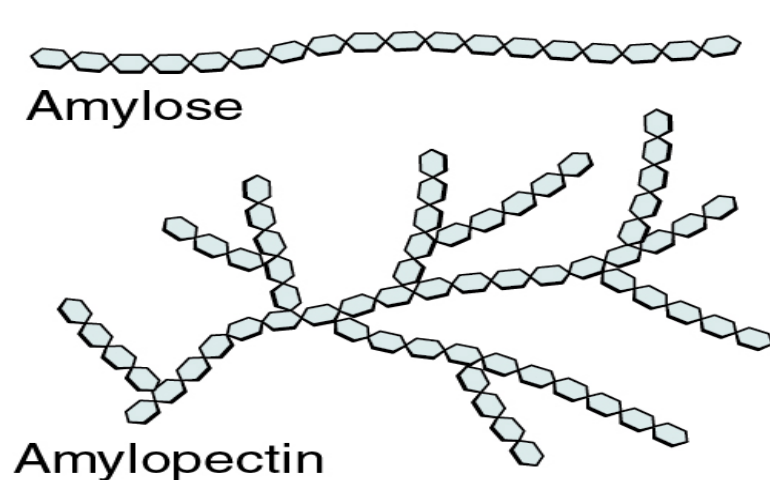


- Polysaccharides are **macromolecules**, polymers with a few **hundred** to a few **thousand** monosaccharides
- Organisms build strong materials from structural polysaccharides

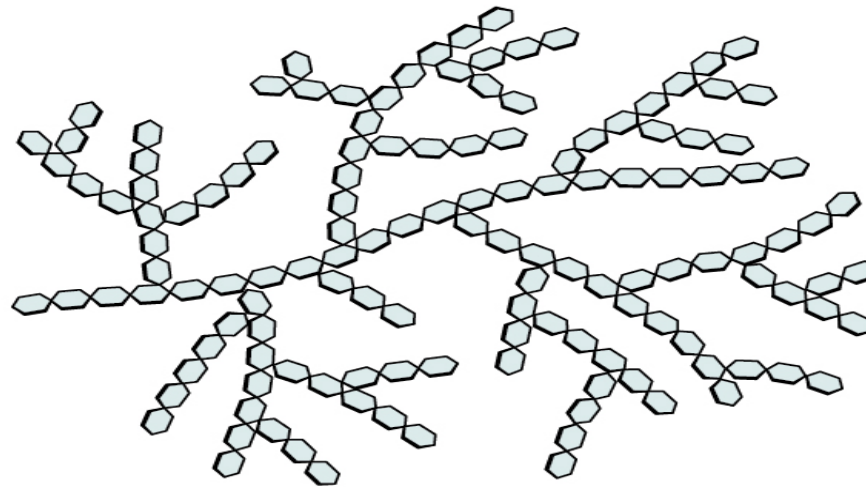
polysaccharides serve as storage material

polysaccharides serve as building material for structures

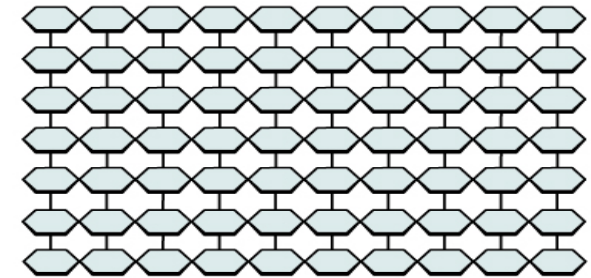
architecture and function of a polysaccharide are determined by its sugar monomers



**Starch**

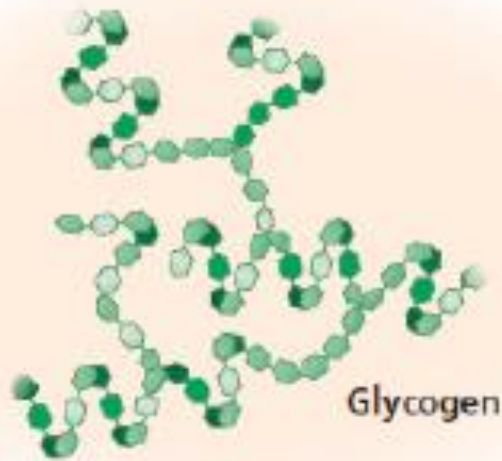
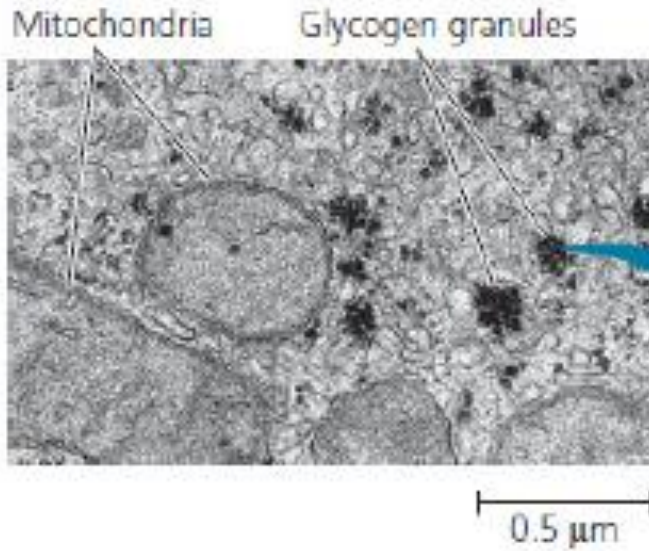
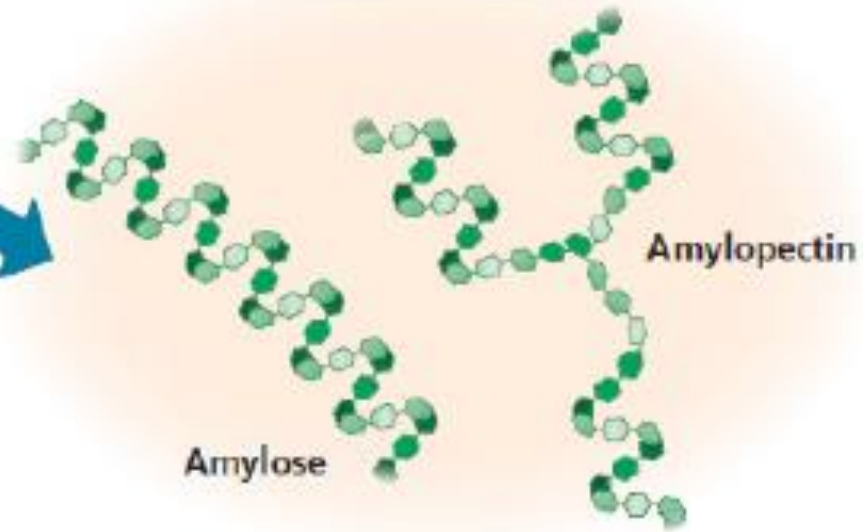
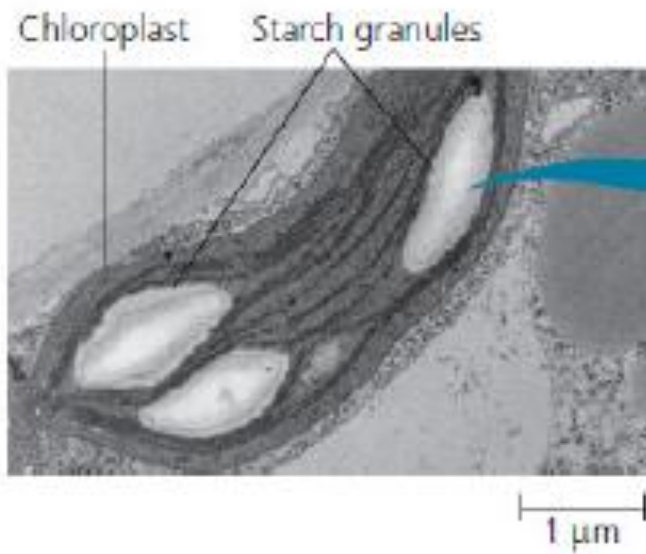


**Glycogen**

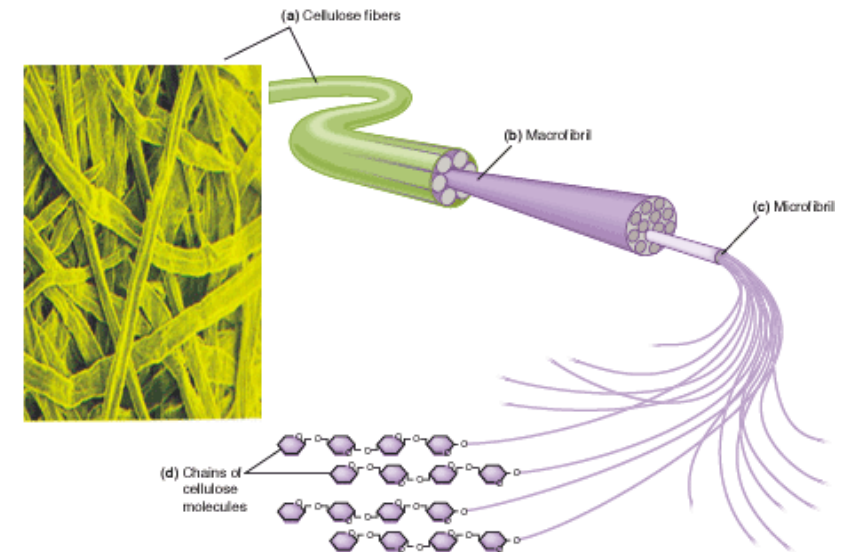
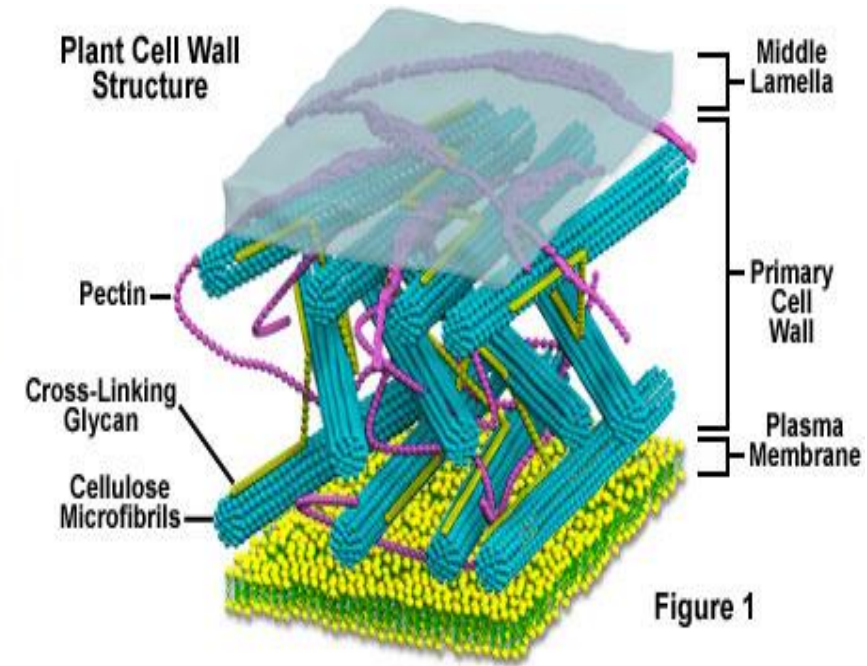


**Cellulose (fiber)**



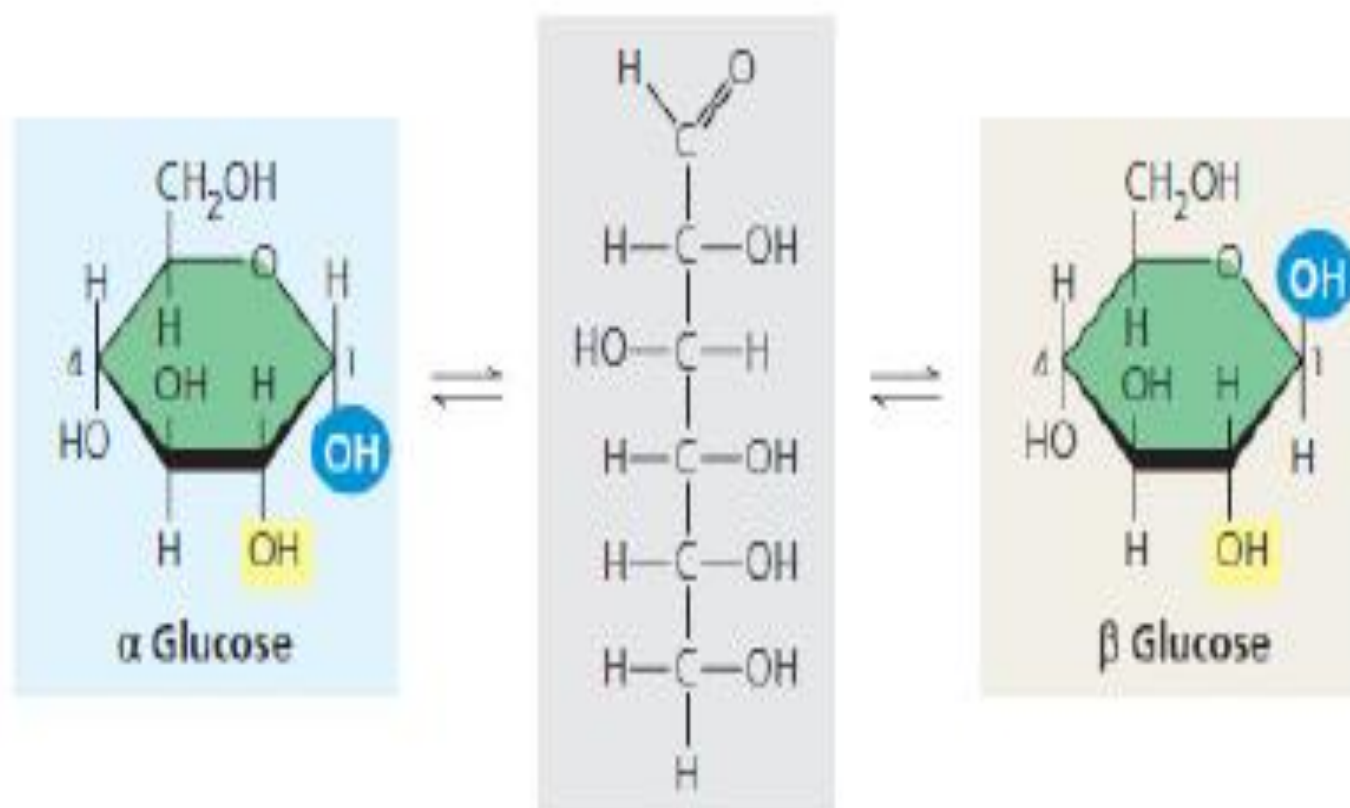


## Structural Polysaccharides



cellulose is a major component of the tough walls that enclose plant cells

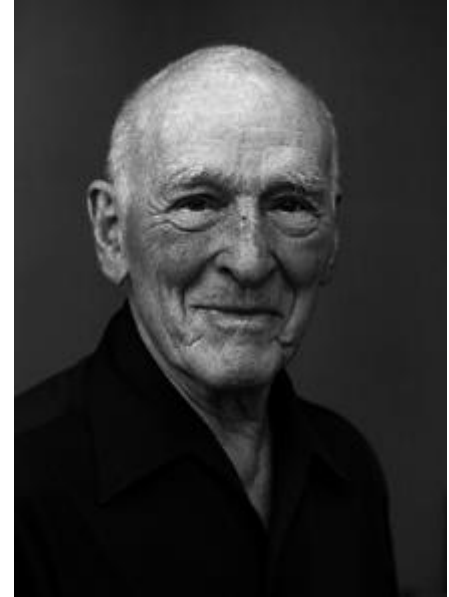
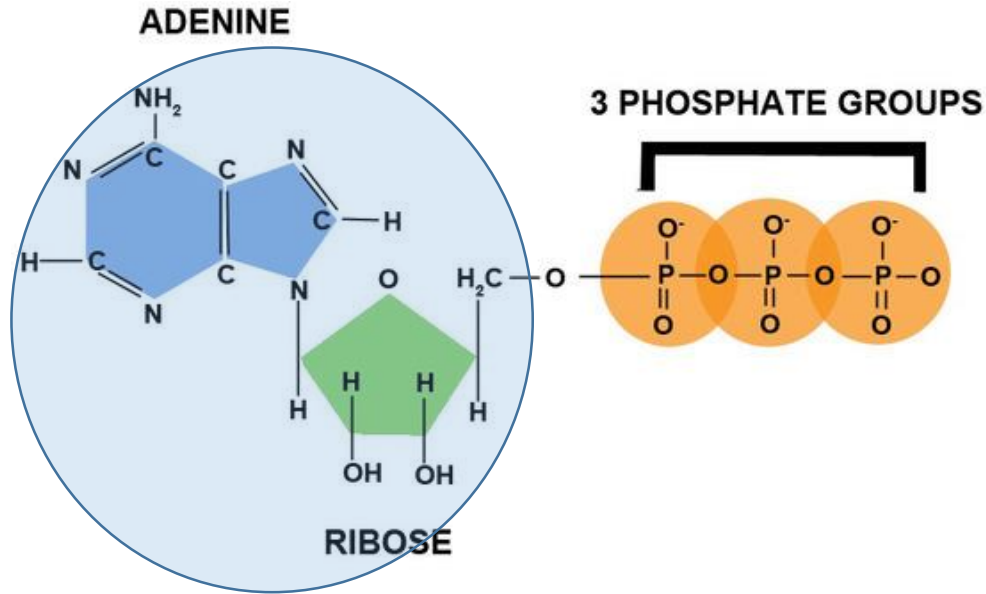
(a)  $\alpha$  and  $\beta$  glucose ring structures. These two interconvertible forms of glucose differ in the placement of the hydroxyl group (highlighted in blue) attached to the number 1 carbon.



# ATP (Adenosine Triphosphate)

"beautiful little machine"

- $C_{10}H_{16}N_5O_{13}P_3$

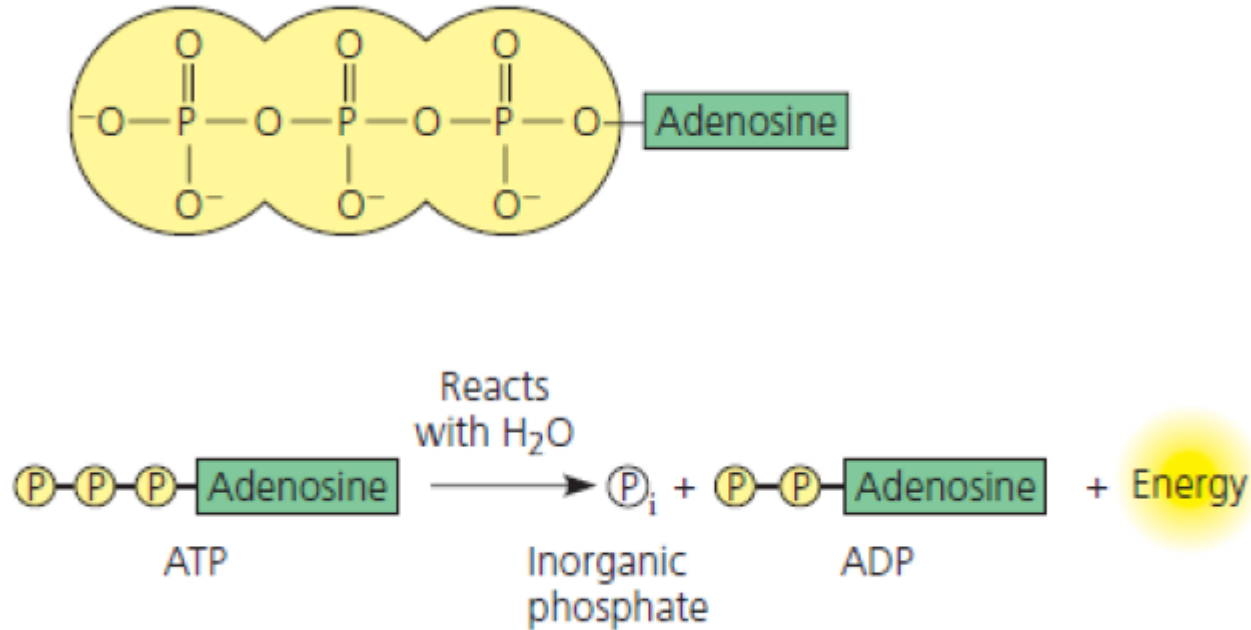


Paul Boyer  
Nobel Prize in Chemistry (1997)

- ✓ ATP is an important source of energy for cellular processes
- ✓ consists of an organic molecule called adenosine attached to a string of three phosphate groups
- ✓  $HOPO_3^{2-}$ , is often referred as a phosphate group
- ✓ While losing this group, it releases energy equivalent to 7.3 Kcal/mol



- Energy required for most of the chemical reactions in the cell is produced by releasing a phosphate group
- Energy is also stored in the form of ATP by the cell



# Reference

- <https://www.boundless.com/biology/textbooks/boundless-biology-textbook/biological-macromolecules-3/lipids-55/phospholipids-300-11433/>