Saccharides – carbon hydrates

$C_n(H_2O)_n$ Ex. $C_6H_{12}O_6$

Monosaccharides

Aldoses
ketoses

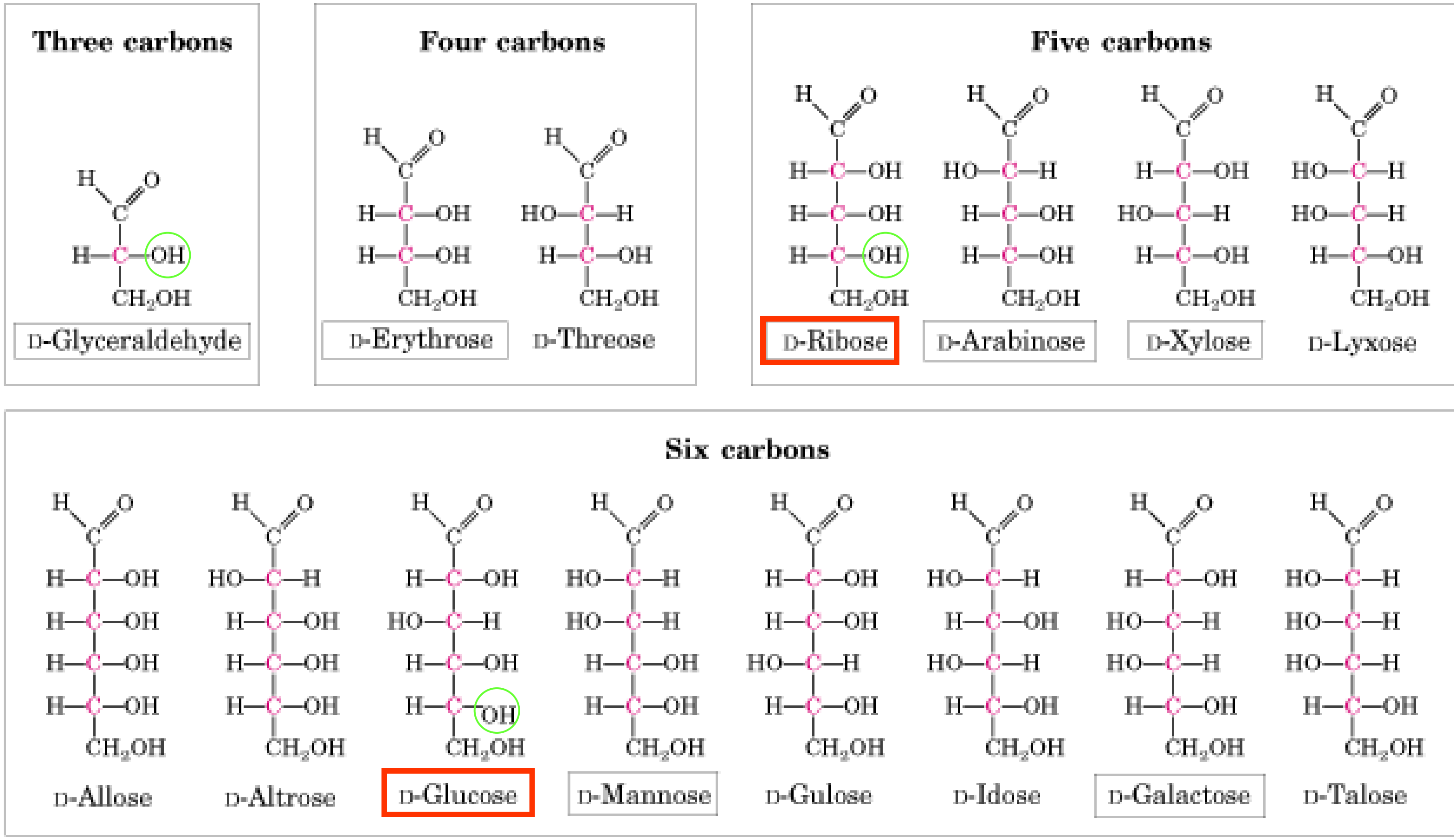
Oligosaccharides

di-saccharides
(O-glycosidic bond)

Polysaccharides

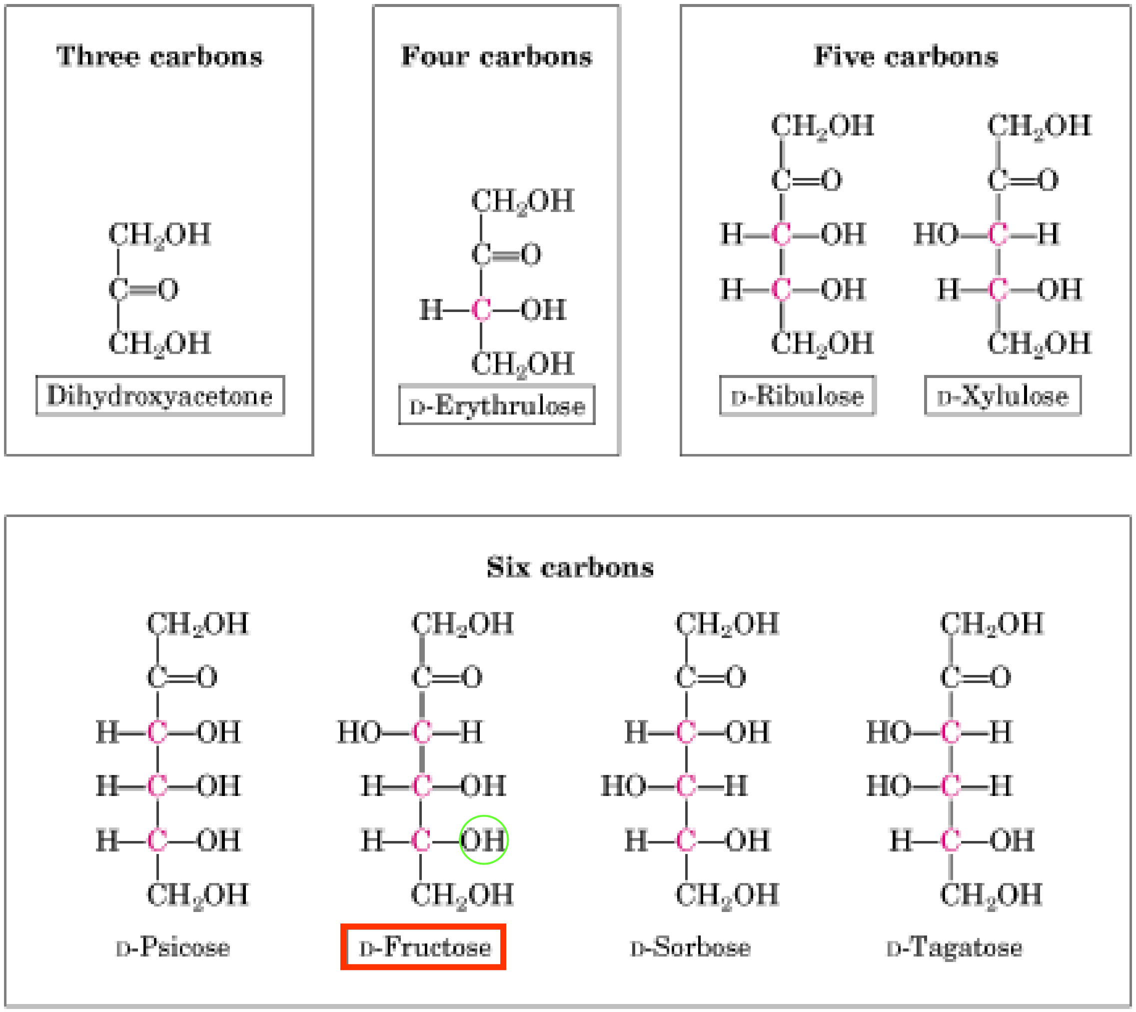
homo-hetero polymers
(O-glycosidic bond)

Aldoses (D-family)



D-Aldoses
(a)

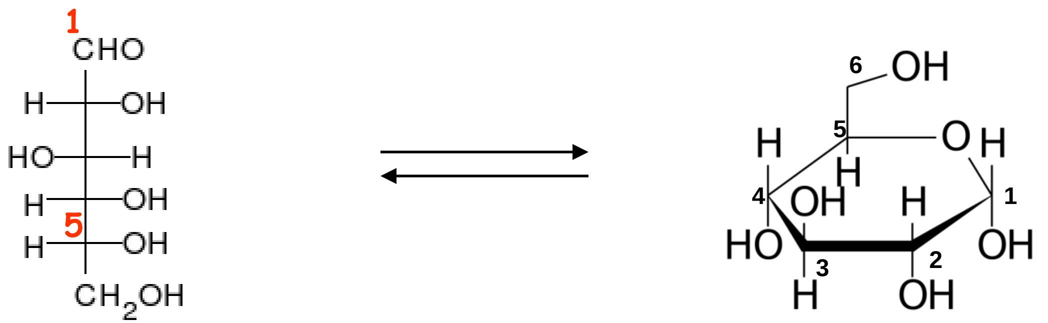
Ketoses (D-family)



D-Ketoses
(b)

Glucose in water solution

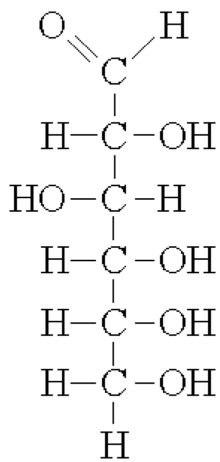
Intra-molecular hemiacetal (1 – 5)



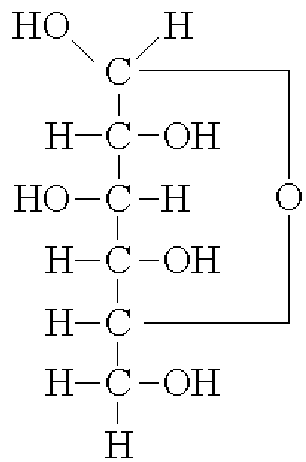
Glucose open chain

Glucopyranose

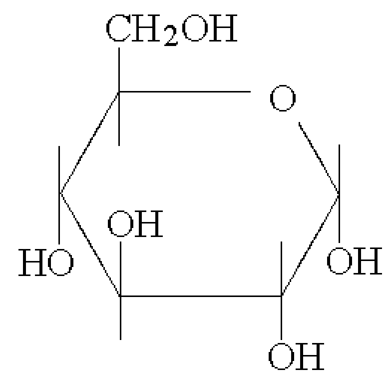
Glucose representation



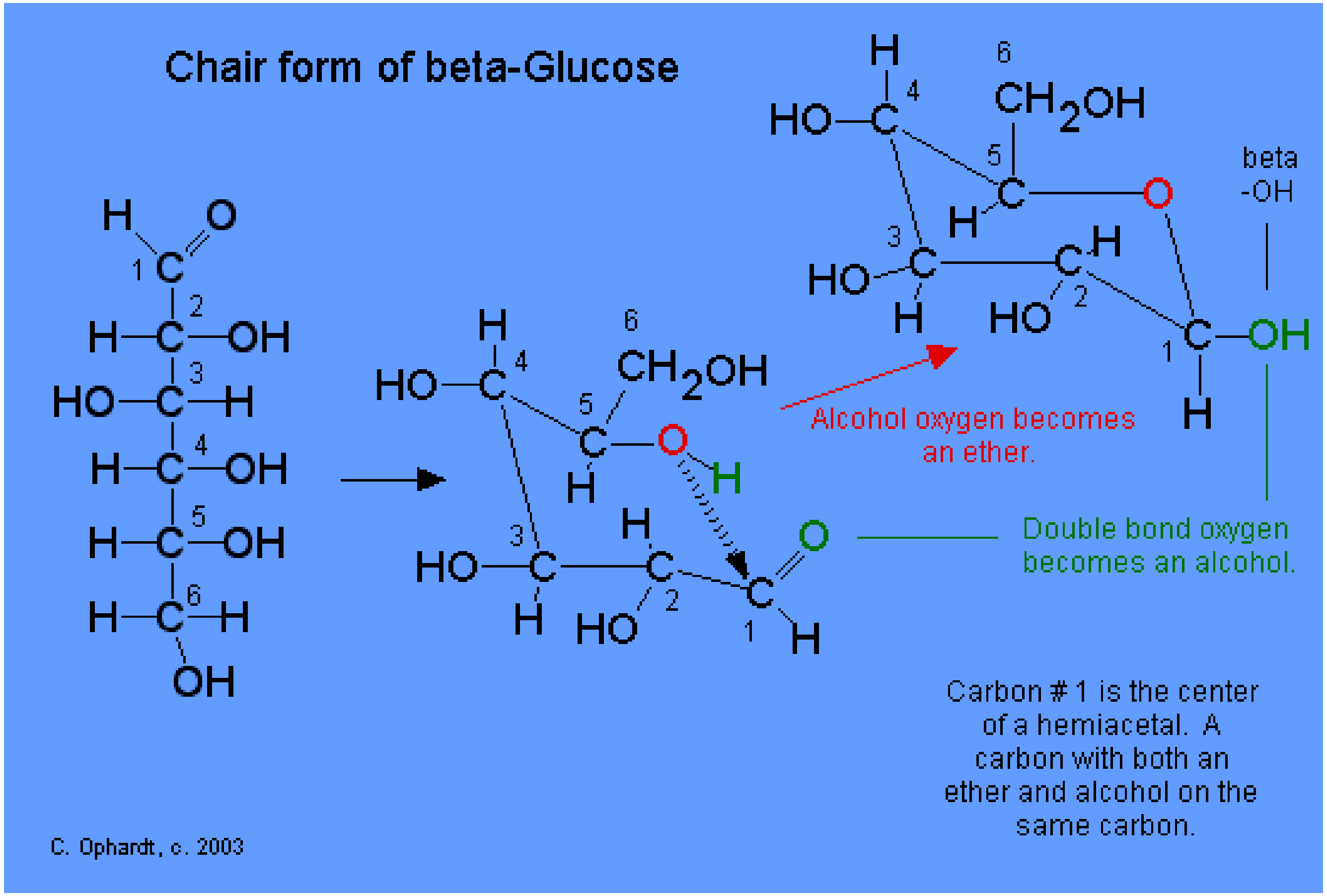
Linear

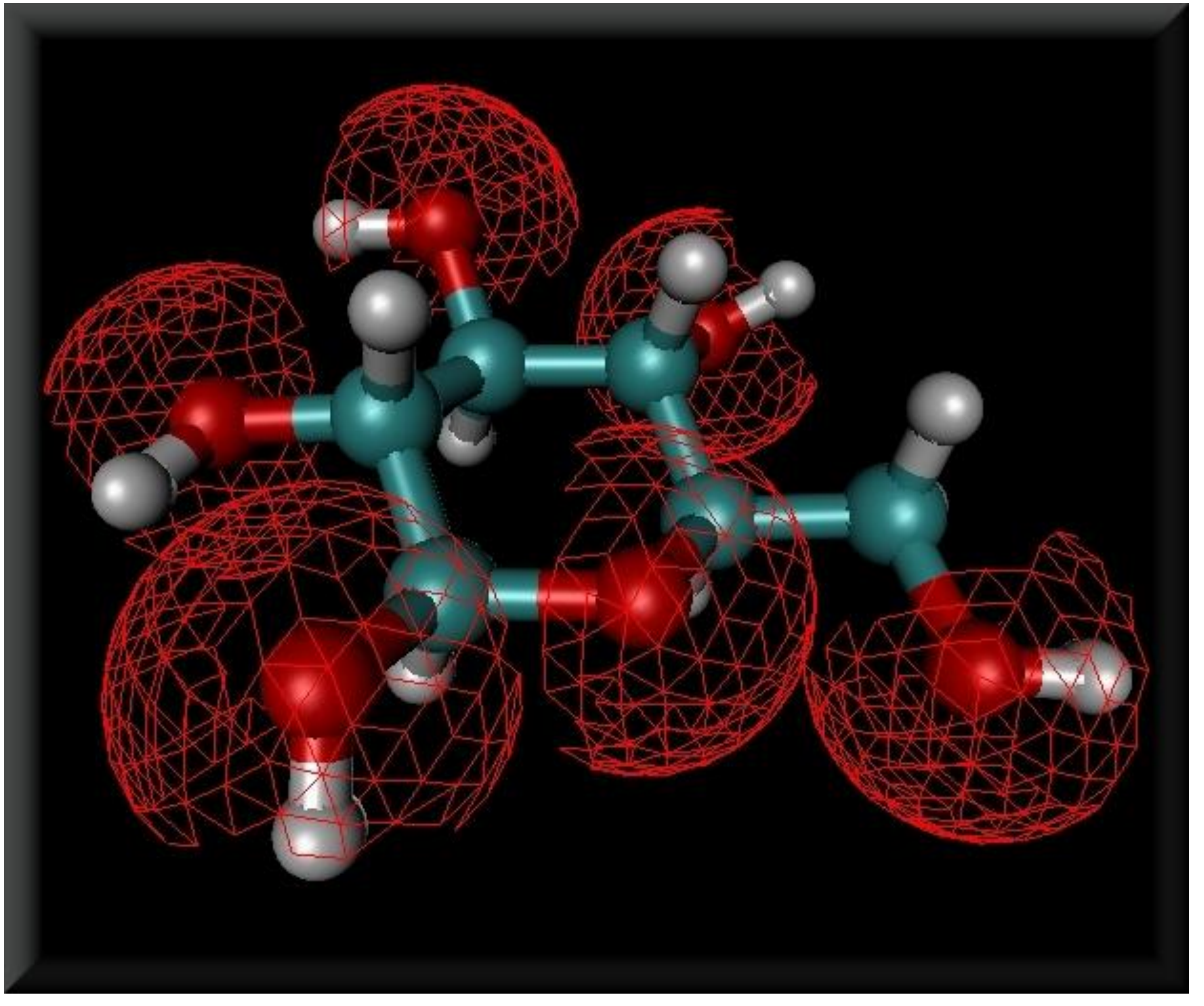


Fischer



Haworth


Chair form of beta-Glucose
beta
-OH
Alcohol oxygen becomes
an ether.
Double bond oxygen
becomes an alcohol.
Carbon # 1 is the center
of a hemiacetal. A
carbon with both an
ether and alcohol on the
same carbon.
C. Ophardt, c. 2003

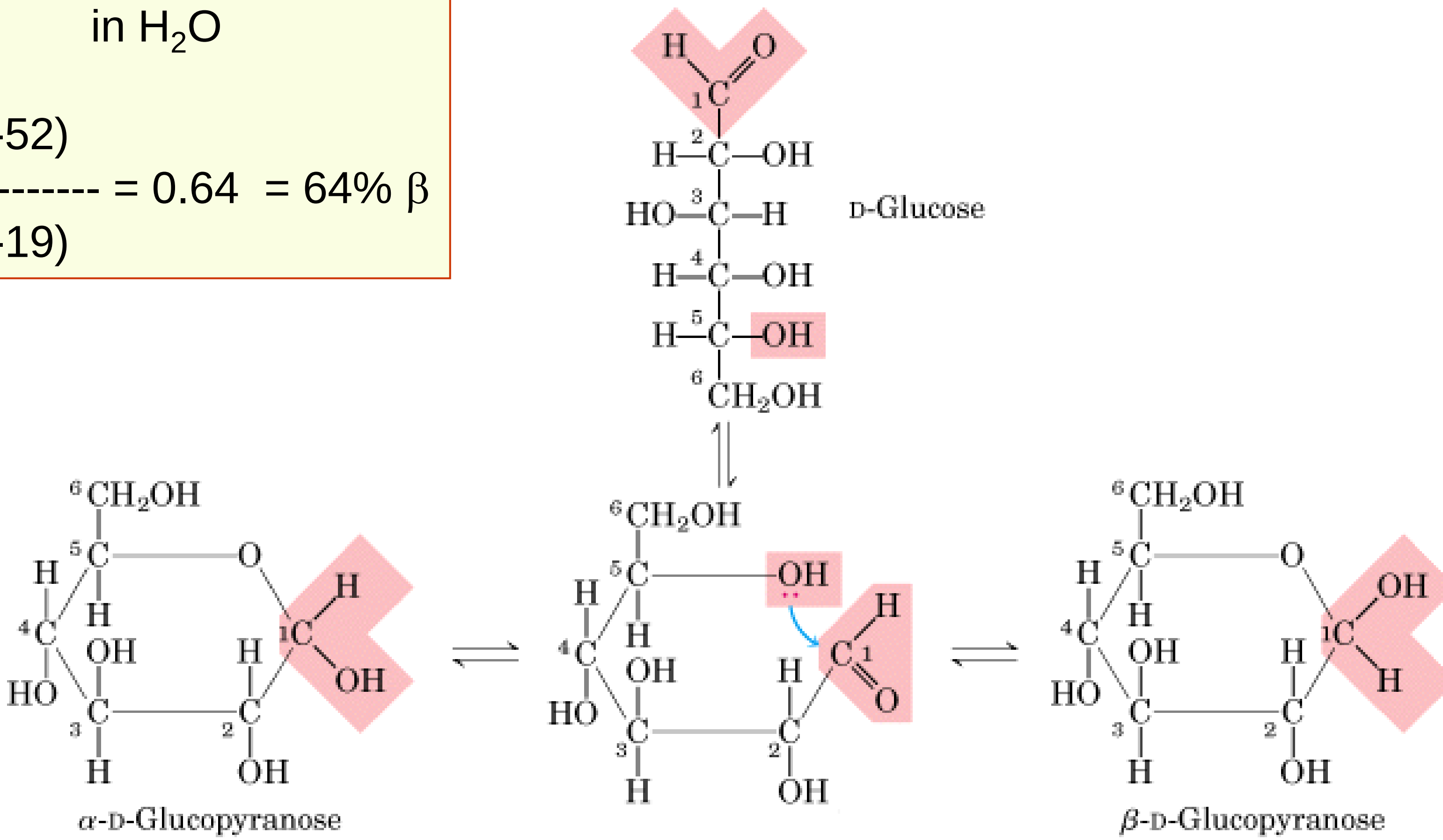


β-D-glucopyranose

MUTAROTATION (H_2O, 20 °C)

in H_2O

$$\frac{(112-52)}{(112-19)} = 0.64 = 64\%\ \beta$$



(+) 112°

52°

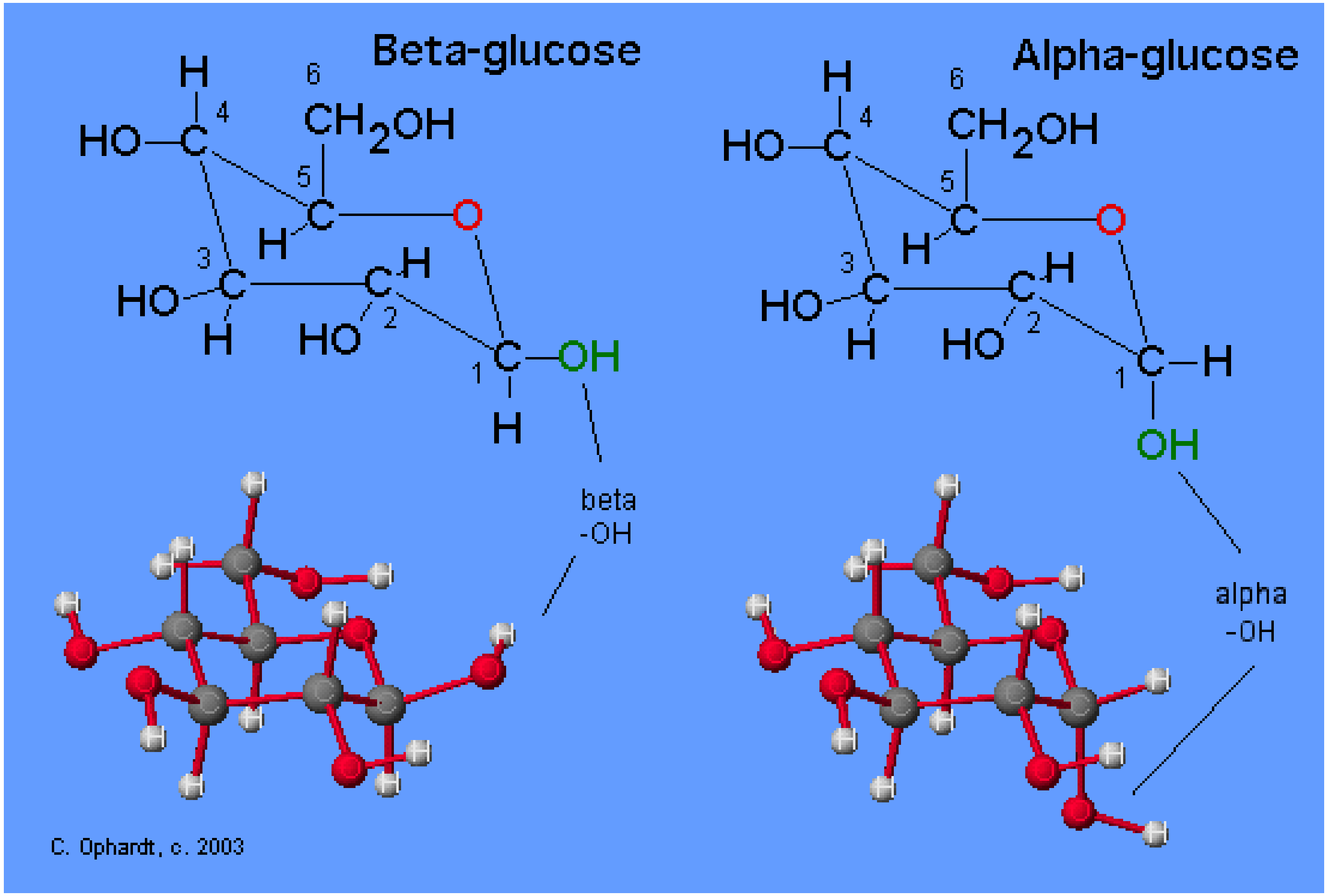
(+) 19°

100 % α

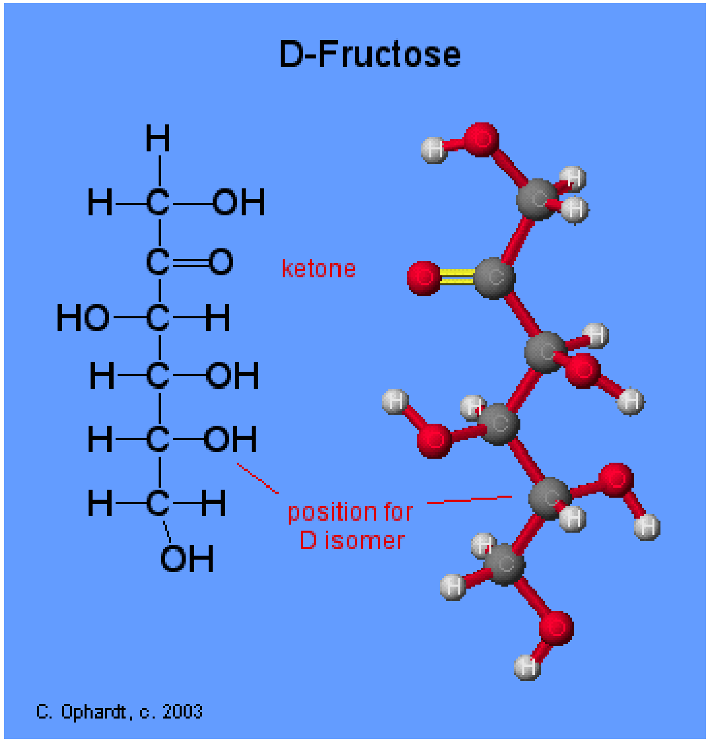
purified in methanol

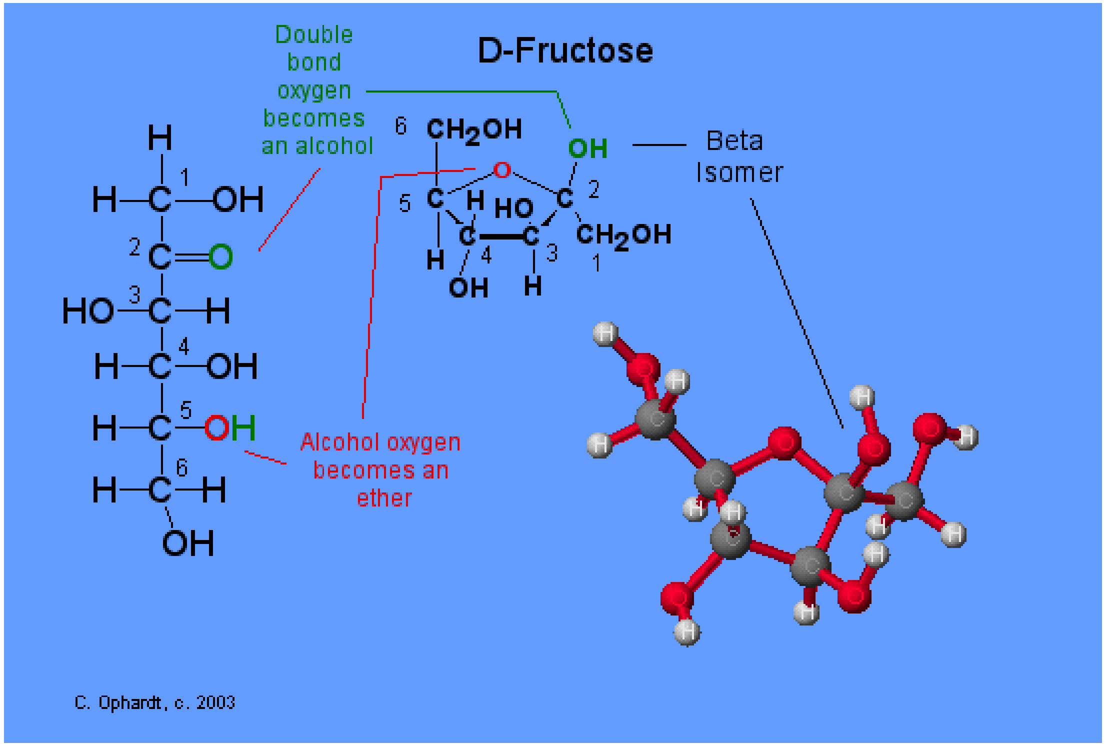
100 % β

in acetic acid

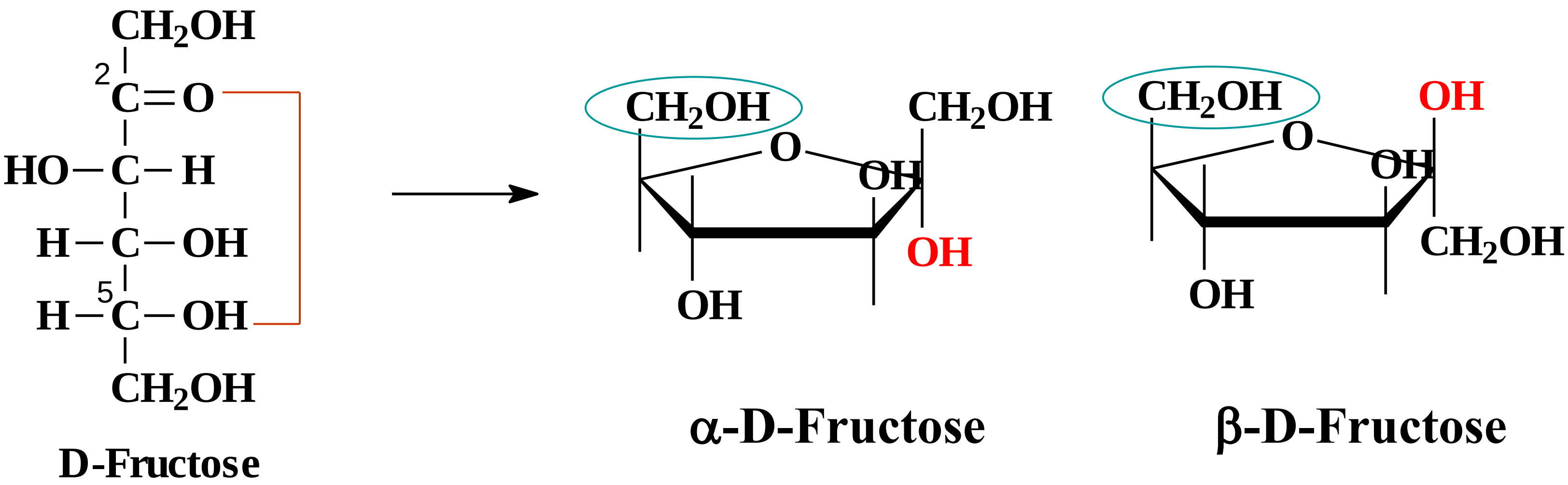


Beta-glucose
Alpha-glucose
beta
-OH
alpha
-OH
C. Ophardt, c. 2003

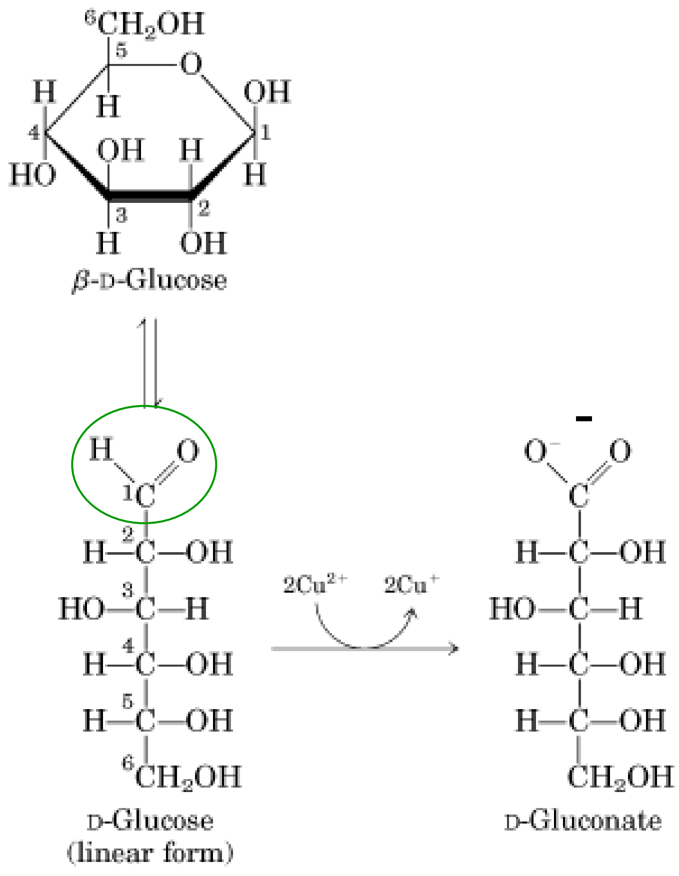

D-Fructose
ketone
position for
D isomer
C. Ophardt, c. 2003


D-Fructose
Double
bond
oxygen
becomes
an alcohol
Beta
Isomer
Alcohol oxygen
becomes an
ether
C. Ophardt, c. 2003

Cyclic Structure of Fructose



Reducing power of saccharides

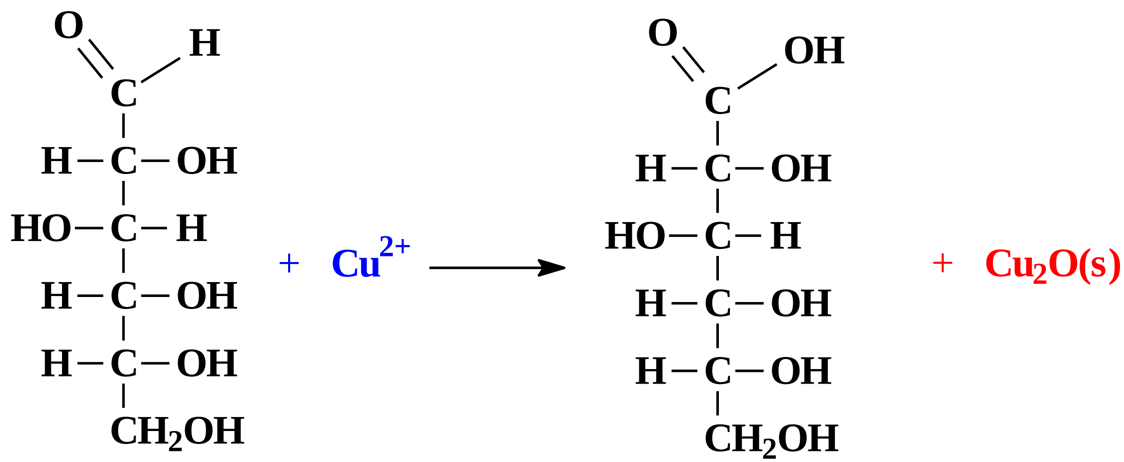


(a)

$$R\text{-}CHO + 2Cu^{2+} \underset{}{\overset{O_2,\ OH^-}{\rightleftharpoons}} R\text{-}COOH + Cu_2O + H_2O$$

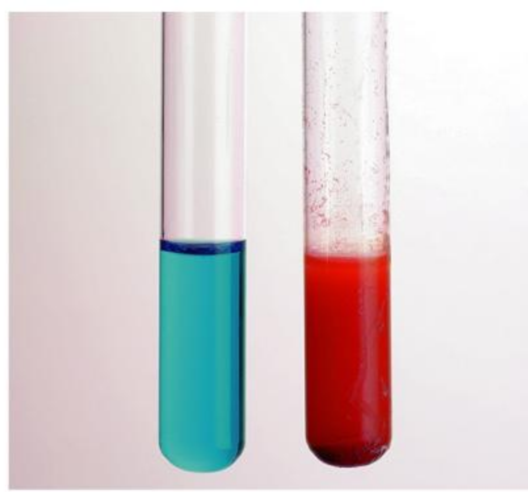
blue ($2Cu^{2+}$) *red* (Cu_2O)

Oxidation of Monosaccharides



D-Glucose

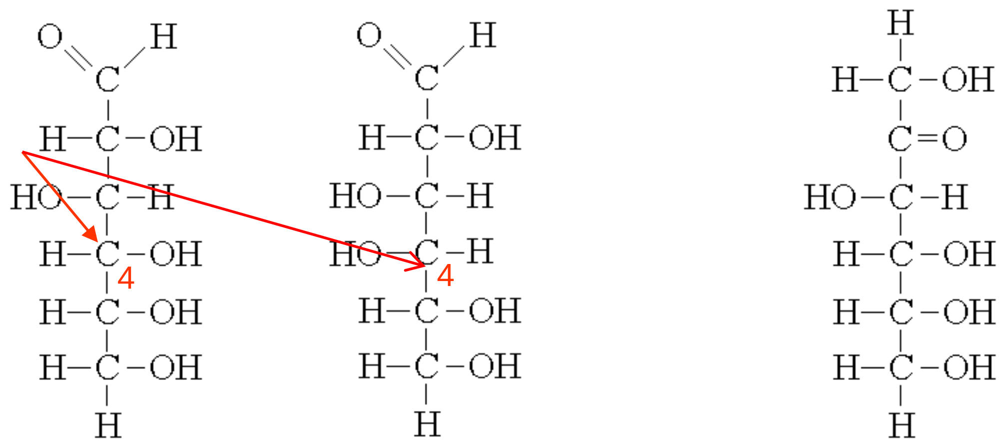
D-Gluconic acid



Cu^{2+} $Cu_2O(s)$

Human (particularly) relevant hexoses

epimers

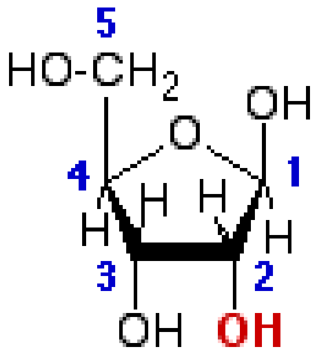


glucose galactose
(*two aldoses*)

fructose
(*ketohexose*)

Glycemia (blood, level) = 90 mg 100 ml (reference range 70 – 110 mg/100 ml)

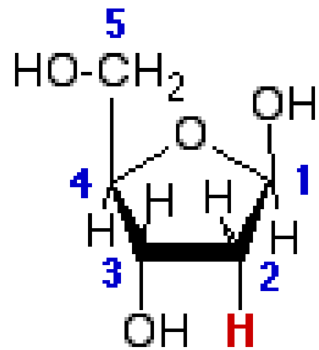
Pentoses relevant to humans



ribose

(β-D-ribofuranose)

(component of ribonucleotides)



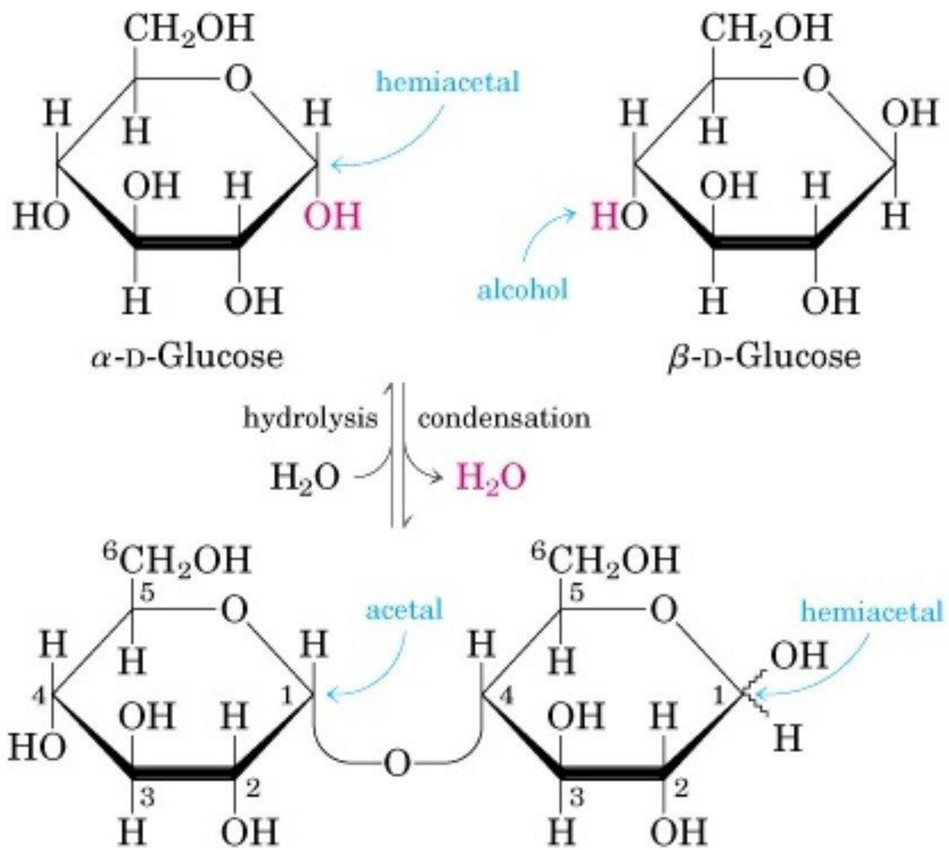
deoxyribose

(β-D-2-deoxyribofuranose)

(component of deoxyribonucleotides)

Di-saccharides

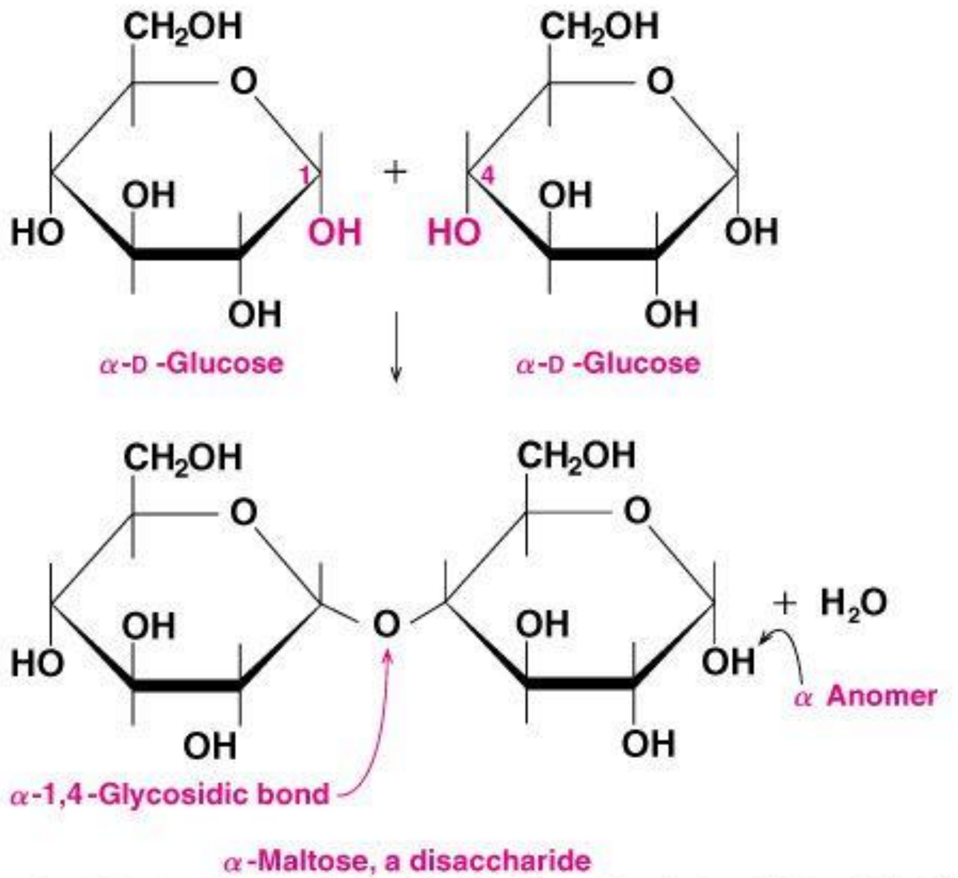
Glycosidic Bond Formation (ether bond)



Maltose

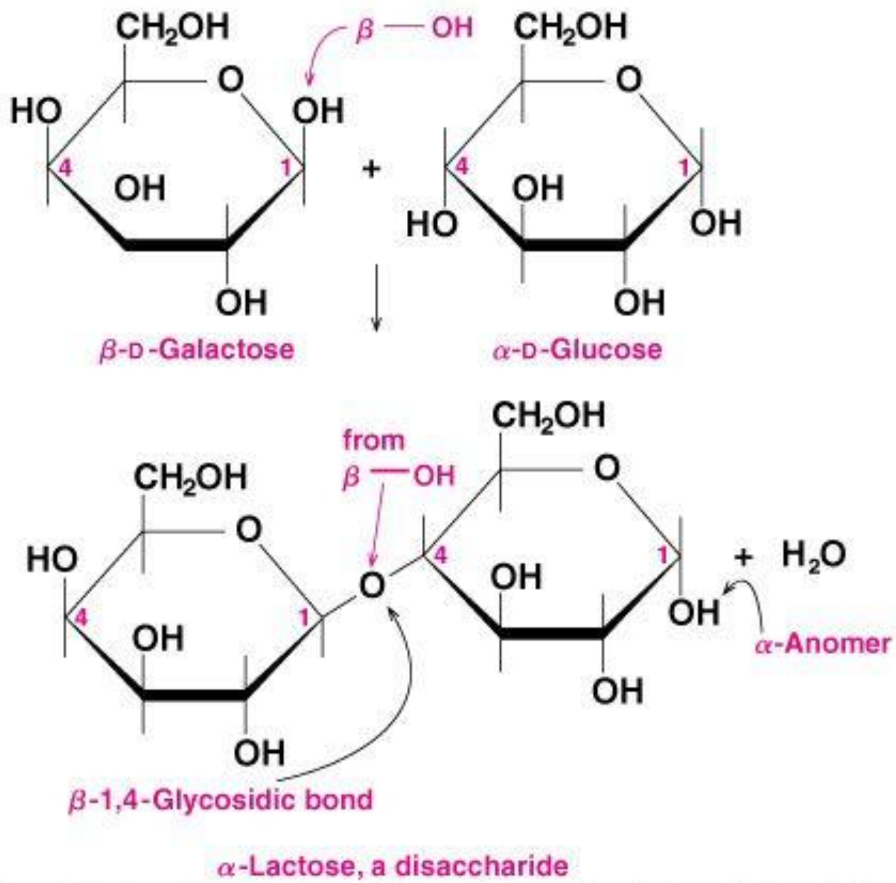
α-D-glucopyranosyl-(1→4)-D-glucopyranose

Maltose



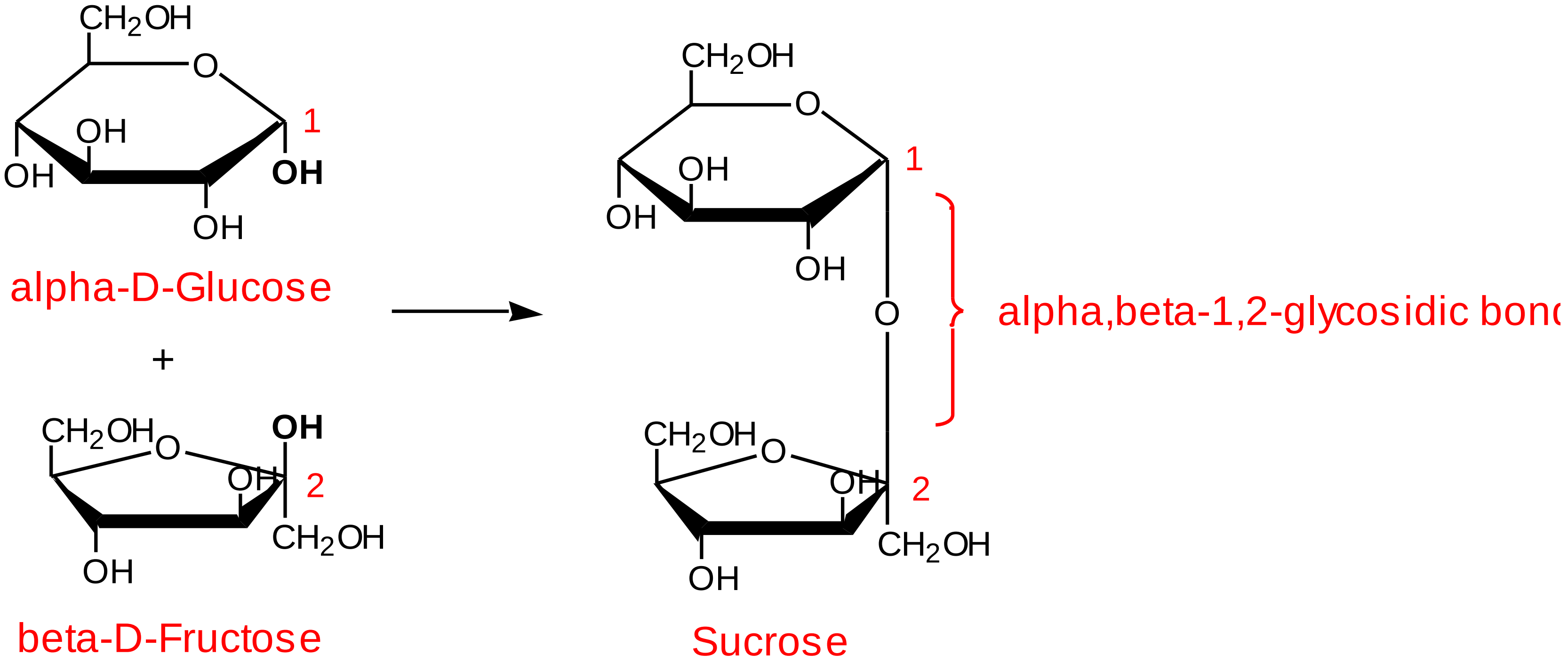
Question: does maltose act as a reductant ?

Lactose

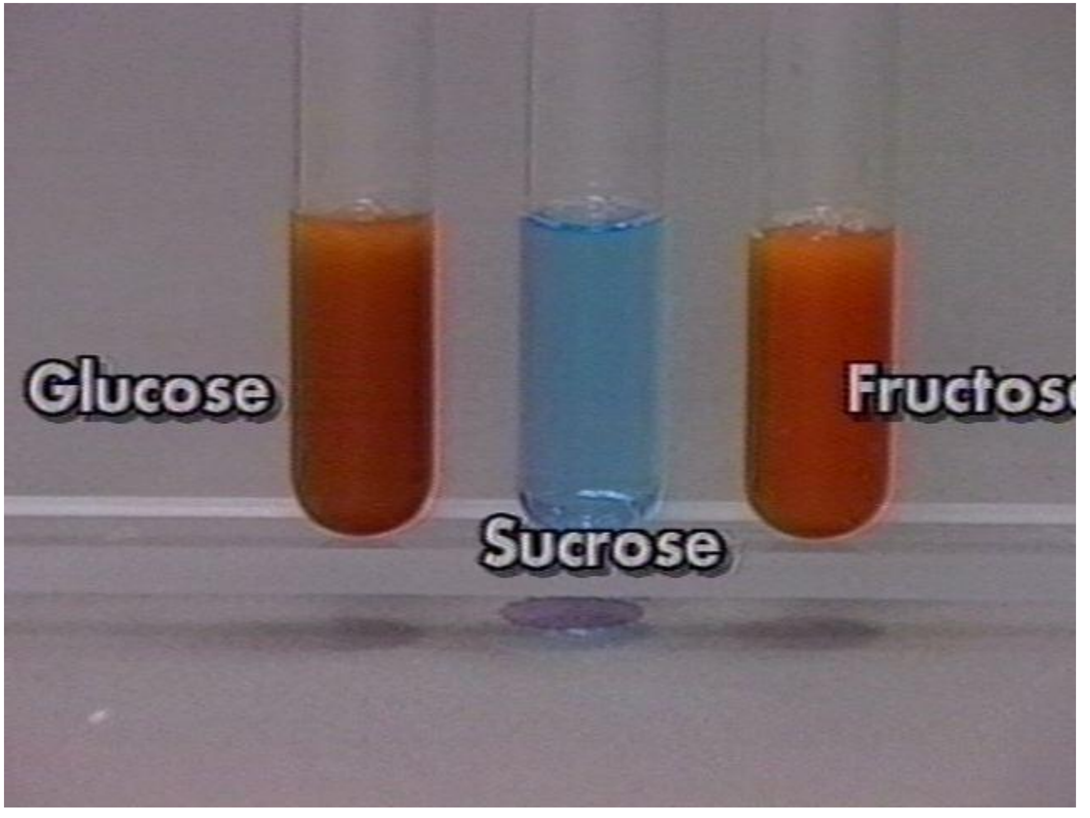


Question: does lactose act as a reductant ?

…and Saccharose…!?

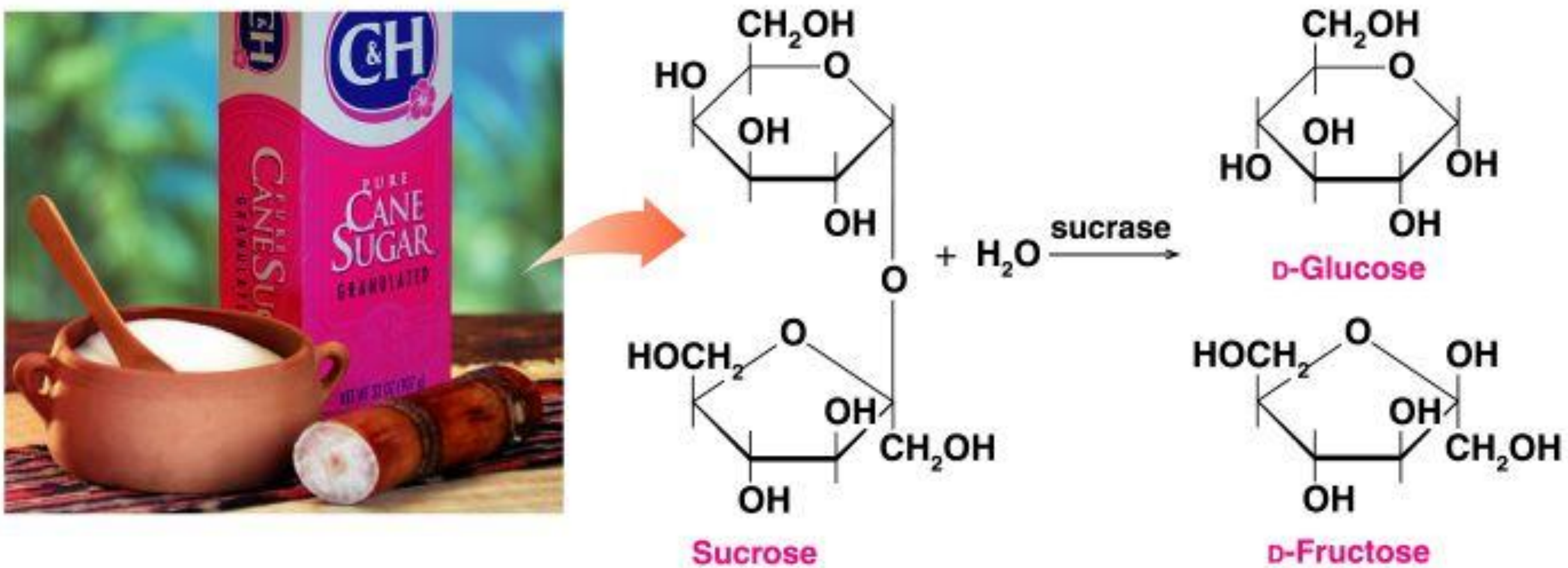


The reducing power of saccharides

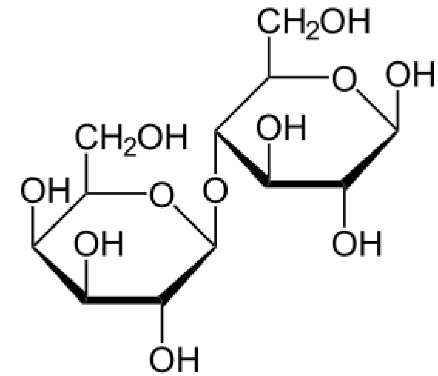


Hydrolysis of Sucrose

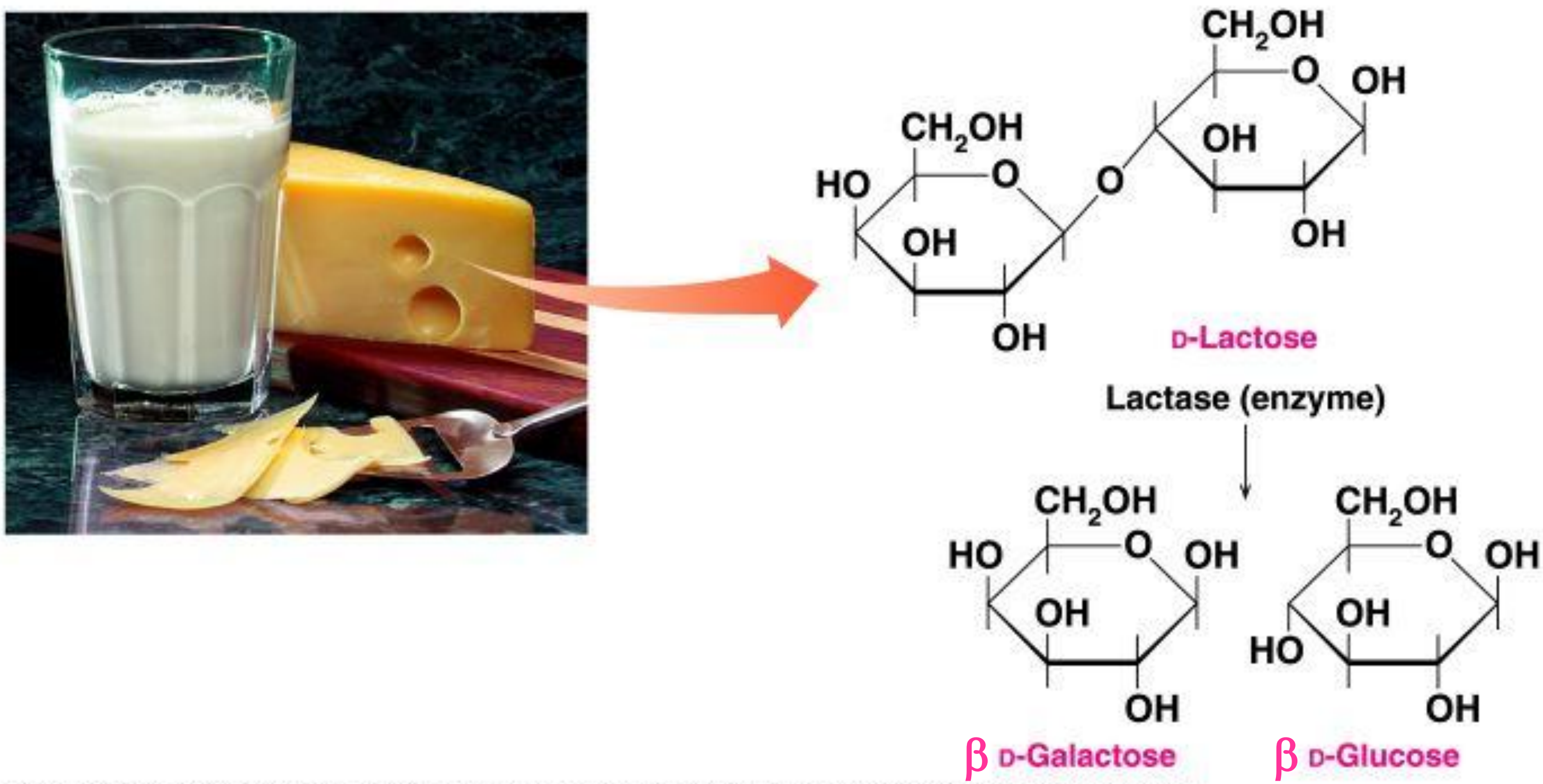
- Sucrose is hydrolyzed by the enzyme sucrase, which is secreted in the small intestine
- The glucose and fructose can then be absorbed into the bloodstream (disaccharides are too large to be absorbed)



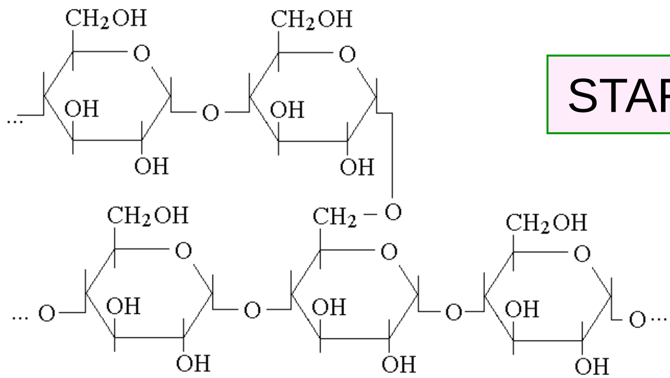
Lactose intolerance



Lactose hydrolysis

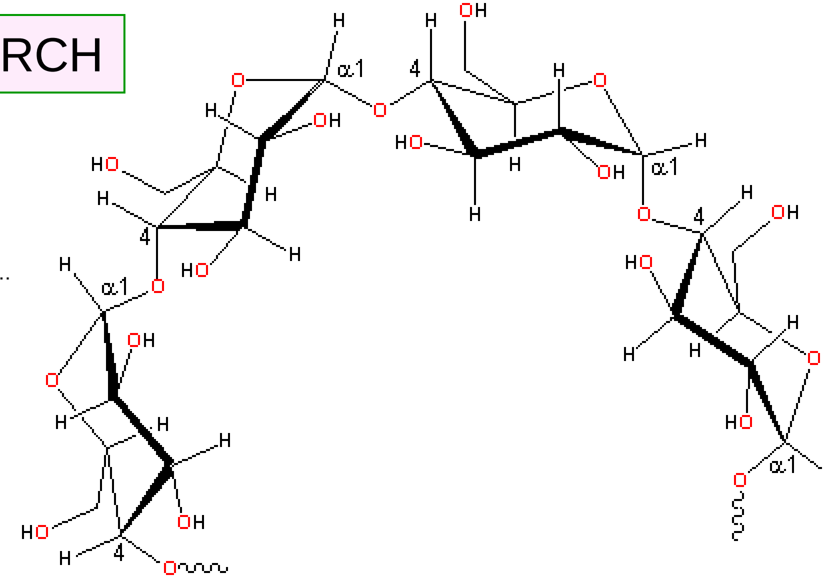


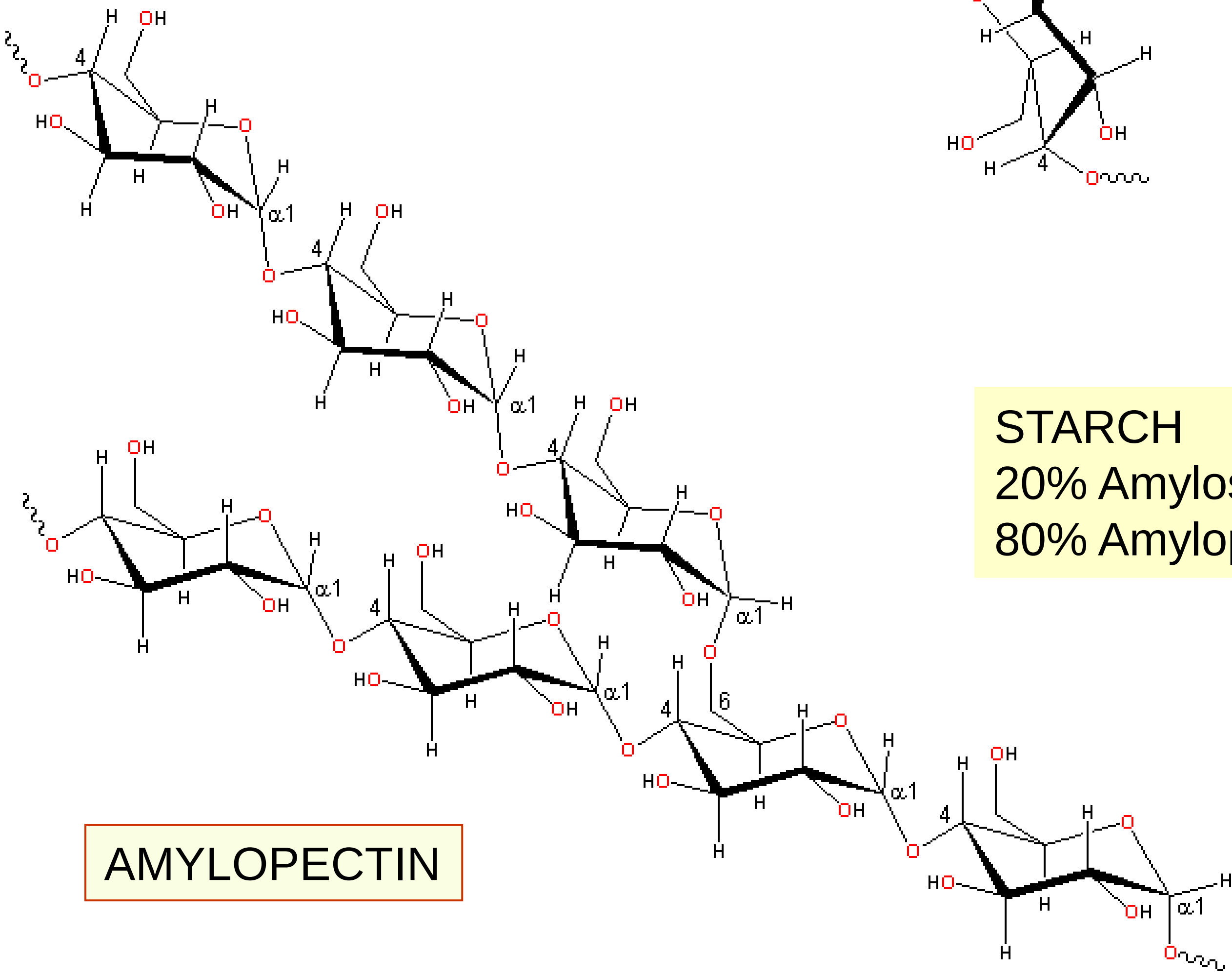
Polymers



Starch & glycogen: branched glucose homopolysaccharides

STARCH

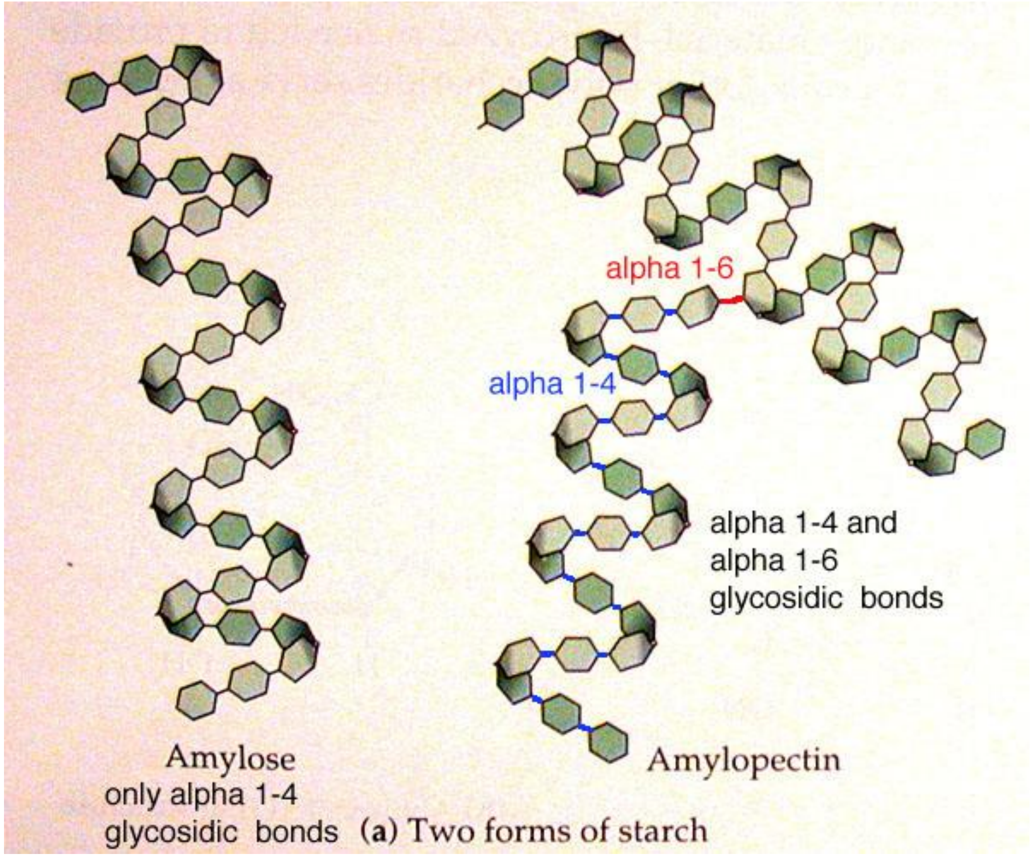




STARCH
20% Amylose = 300-3000
80% Amylopectin = 2000 - 3000

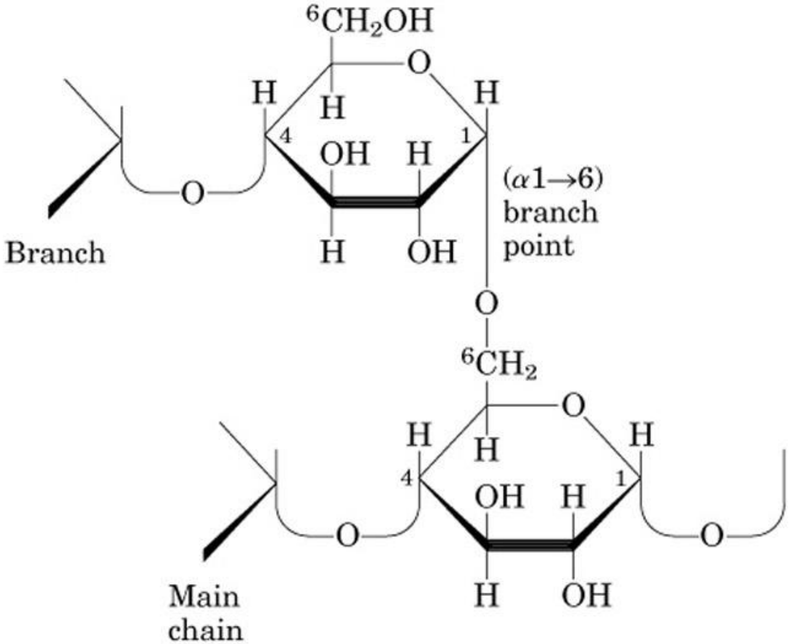
AMYLOPECTIN

STARCH
20% Amylose = 300-3000
80% Amylopectin = 2000 - 3000



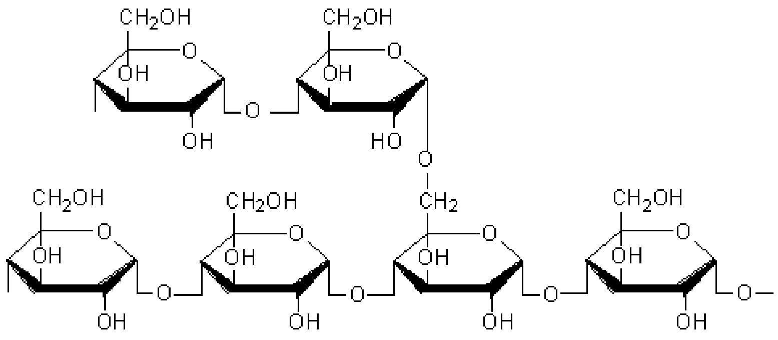
(a) Two forms of starch

Glycogen & Amylopectins

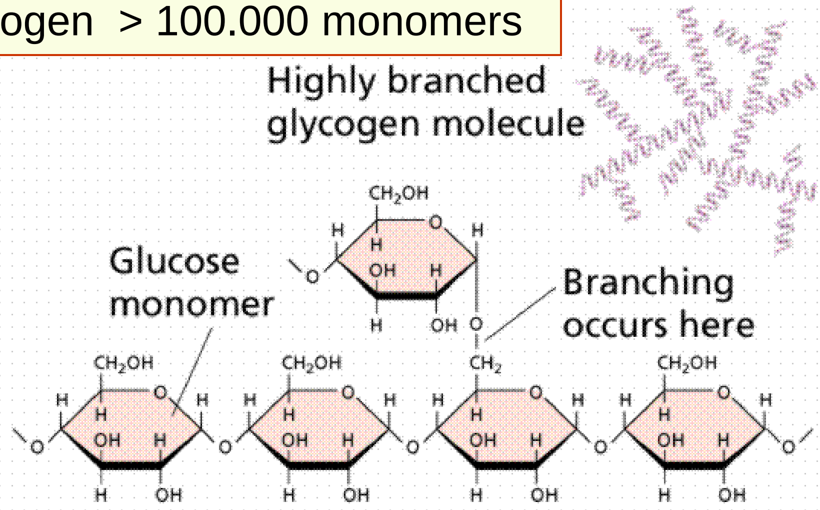


(b)

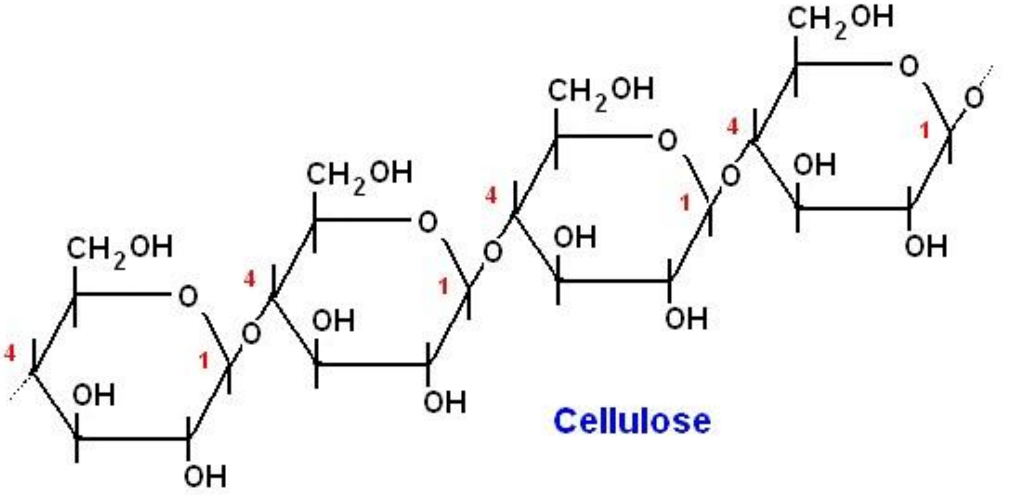
Amylopectins > 2000 monomers



Glycogen > 100.000 monomers



Cellulose



β 1,4 O-glycosidic bonds – linear polymers > 10.000 monomers

Does starch possess reducing power ?