Carbohydrates – Summary

A. Monosaccharides

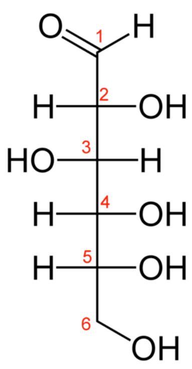
Carbonyl group

- Ketose – ketone function
  - Cannot reduce Cu^{2+} to Cu^{+}
- Aldose – aldehyde function
  - Can reduce Cu^{2+} to Cu^{+}

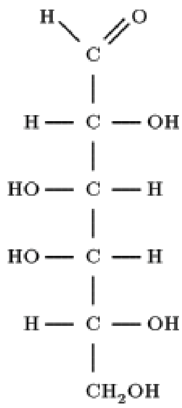
$(CH_2O)_n$

Isomers (Spatial Arrangment):

- E.G.



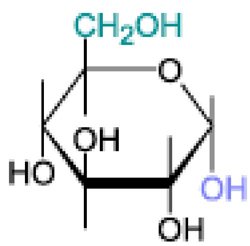
glucose



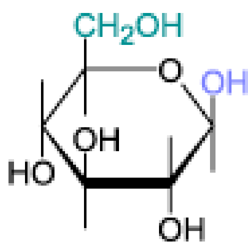
galactose

1

- E.G. 2 :
  - α-glucose
    - carbon 1 –OH below
  - β-glucose
    - carbon 1 –OH above
  - both are different spatial arrangements of glucose. Ring opens to straight chain then close to the other isomer.



α-glucose

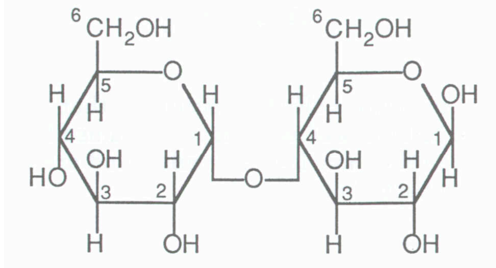
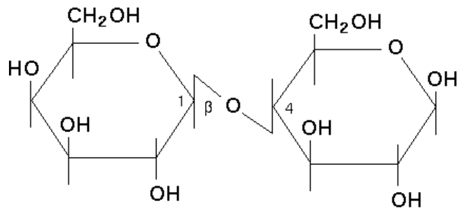
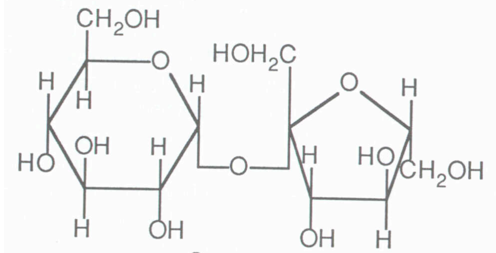


β-glucose

B. Disaccharides

2 monosaccharides joined by a **GLYCOSIDIC BOND**

- Covalent bond
- DEHYDRATION SYNTHESIS (condesation reaction) *hydrolysis is the reverse

Maltose	**α-glucose** + **α-glucose**	α(1→4) glycosidic bond	 Maltose
	Reducing 1 free carbonyl group		
Lactose	**α-glucose** + **β-galactose**	β(1→4) glycosidic bond	Lactose 
	Reducing 1 free carbonyl group (the other on β-galactose is involved in the formation of the glycosidic bond)		
Sucrose	**α-glucose** + **β-fructose**	α(1→2) glycosidic bond	 Sucrose
	NON-reducing No free carbonyl groups		

C. Reducing Sugars

FOR REDUCING SUGARS:

Benedict's Test OR Fehling's Test

Benedict's Test (Involving Cu_2SO_4):

1. Place $2cm^3$ of test solution in a test tube
2. Add equal volume of Benedict's reagent
3. Shake the mixture
4. Heat by immersing test tube in **boiling** water bath (3 - 4 min)
5. Observe contents of test tube

Colour Of Precipitate	**Deduction (Amt. of reducing sugars)**
Blue (Same as original)	No reducing sugars
Green	Small amount
Yellow	Moderate amount
Brown	Moderately large amount
Brick-red	Large amount

FOR NON-REDUCING SUGARS:

Acid hydrolysis followed by Benedict's test:

1. Negative result for Benedict's test obtained
2. Boil equal volume of test solution with dil. HCL (1 min)
3. Cool contents of test tube
4. Neutralise the content with $NaHCO_3$ (aq) *Benedict's solution works only under alkaline conditions
5. Carry out Benedict's test
6. Record observations

Observation	**Deduction**
1st test with Benedict's solution → blue solution remains 2nd test after acid hydrolysis → a (insert colour here) ppt forms	Non-reducing sugars present
1st test with Benedict's solution → blue solution remains 2nd test after acid hydrolysis → blue solution remains	Non-reducing sugars absent

D. Polysaccharides

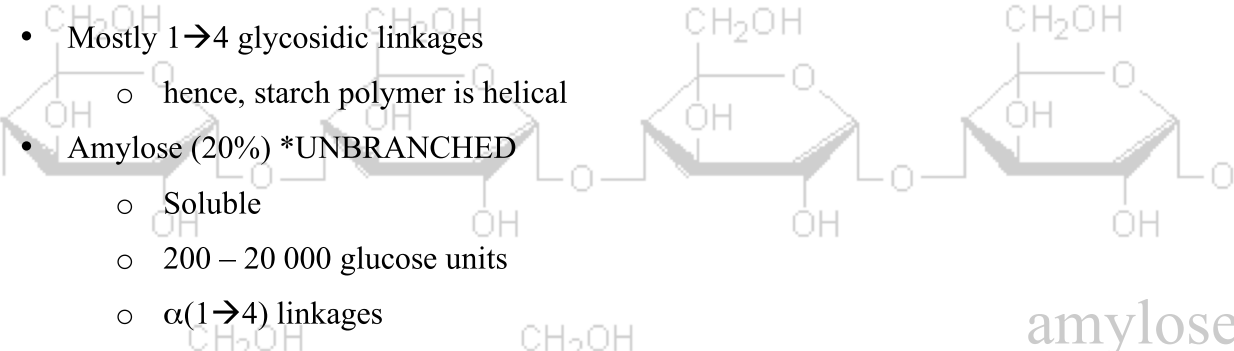
STORAGE POLYSACCHARIDES

Structure and Function

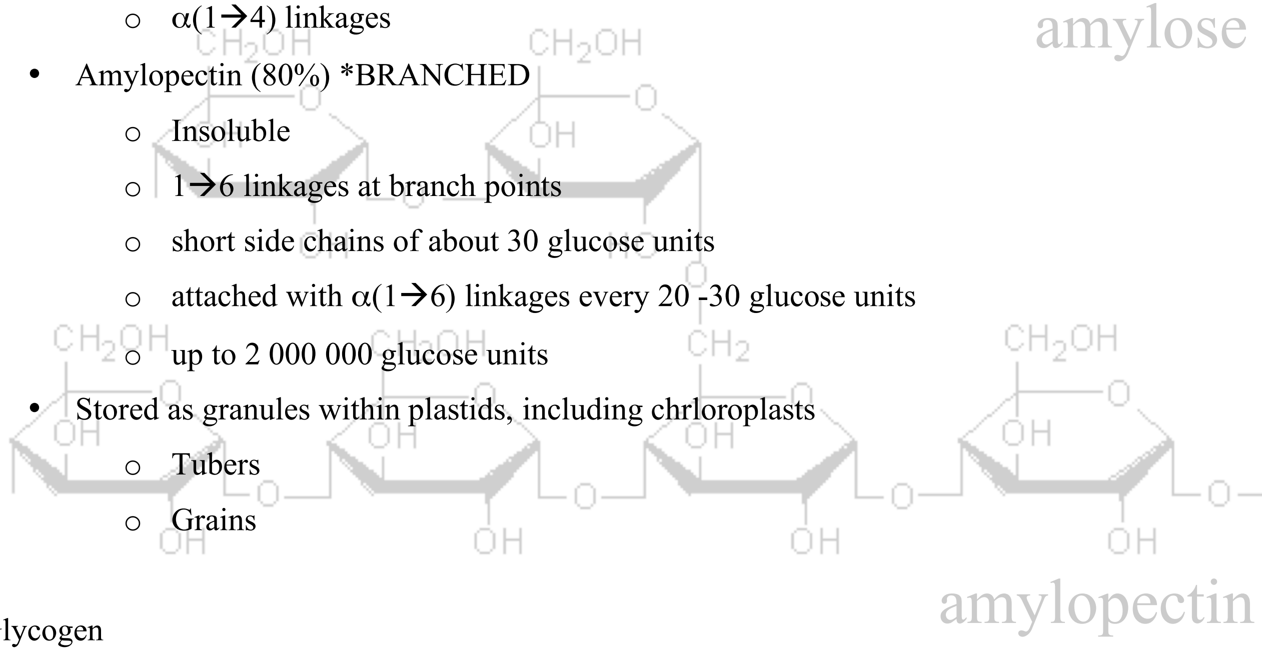
- Many α-glucose residues
    - Large energy store
    - Insoluble/slightly soluble only
        - Will not affect Ψ_W of cells
- Linear chains coiled into helices
    - Compact storage
- α(1→4) and α(1→6) linkages

Starch

- Only glucose monomers
- Mostly 1→4 glycosidic linkages
    - hence, starch polymer is helical
- Amylose (20%) *UNBRANCHED
    - Soluble
    - 200 – 20 000 glucose units
    - α(1→4) linkages



- Amylopectin (80%) *BRANCHED
    - Insoluble
    - 1→6 linkages at branch points
    - short side chains of about 30 glucose units
    - attached with α(1→6) linkages every 20 -30 glucose units
    - up to 2 000 000 glucose units
- Stored as granules within plastids, including chrloroplasts
    - Tubers
    - Grains



Glycogen

- α(1→4) and α(1→6) linkages (like amylopectin)
    - but more extensively branched – more ends for enzymes to hydrolyse.
- Stored in mainly liver and muscle cells

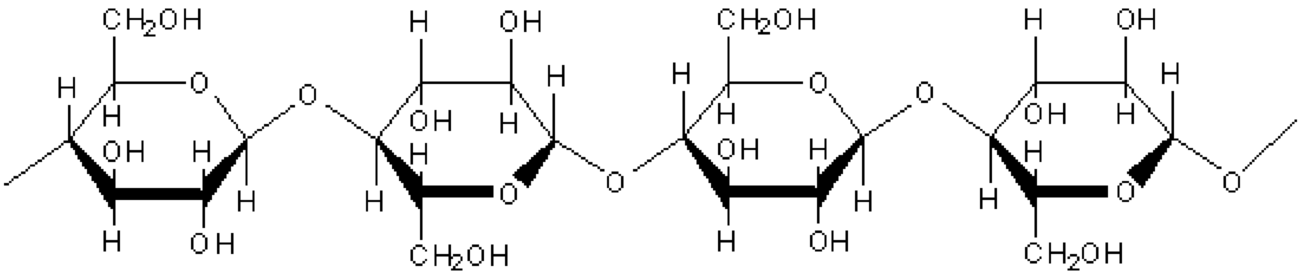
- Hydrolysis yields glucose

STRUCTURAL POLYSACCHARIDES

Cellulose & Chitin

- Chitin is not required by syllabus

Cellulose



- Most abundant organic compound on earth
- Major component of plant cell walls
- Polymer of **β-glucose** monomers
- Cellulose molecule is straight and hydroxyl groups project out in both directions
    - Each alternate monomer is upside down (owing to β-glucose monomers)
- Intermolecular H-bonding
    - Forms microfibrils between straight chains of cellulose molecules
    - Enzymes that digest starch by hydrolysing its α-linkages are unable to hydrolyse the β-linkages.