LOCKIN EDUCATION @ BUGIS

H2 Biology

Summary Notes Revision Package

"To study Biology is to study life itself — and to understand it is to think with precision."

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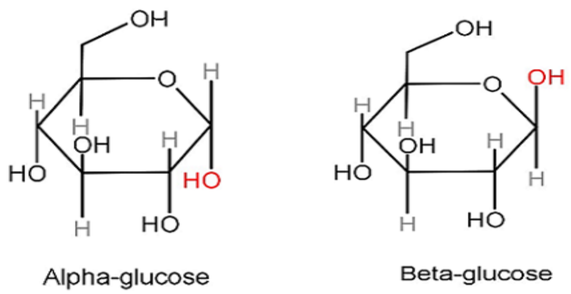
Carbohydrates

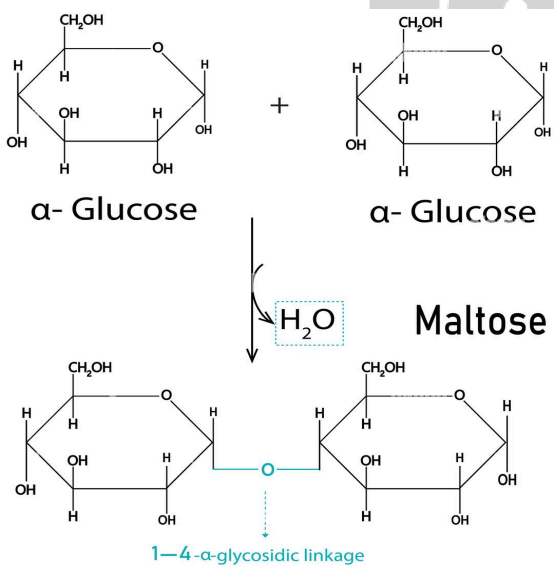
<table>
<tr><td colspan="2">Carbohydrates: generally (CH_2O)[redacted]</td></tr>
<tr><td>Monosaccharides: $\mathbf{C_6H_{12}O_6}$</td><td>Features</td></tr>
<tr><td>



Difference lies in position of -OH group on Carbon-1</td><td><u>Glucose</u> ; <u>Galactose</u> ; <u>Fructose</u>
→ All are reducing sugars due to free carbonyl group (C=O)

→ Small size & have multiple hydroxyl groups (-OH) and can form hydrogen bonds with water ;
Readily soluble in water!

<u>Solubility</u>: how well something can INTERACT with water (Interact means more than just H-bonds; it can mean ionic interactions, van der waals, etc.)</td></tr>
<tr><td>Disaccharides: $\mathbf{C_{12}H_{22}O_{11}}$</td><td>Features</td></tr>
<tr><td>



</td><td>Glucose + Glucose → Maltose [GGM]
Glucose + Galactose → Lactose [GGaL]
Glucose + Fructose → Sucrose [GFS]
=> All reducing sugars EXCEPT Sucrose

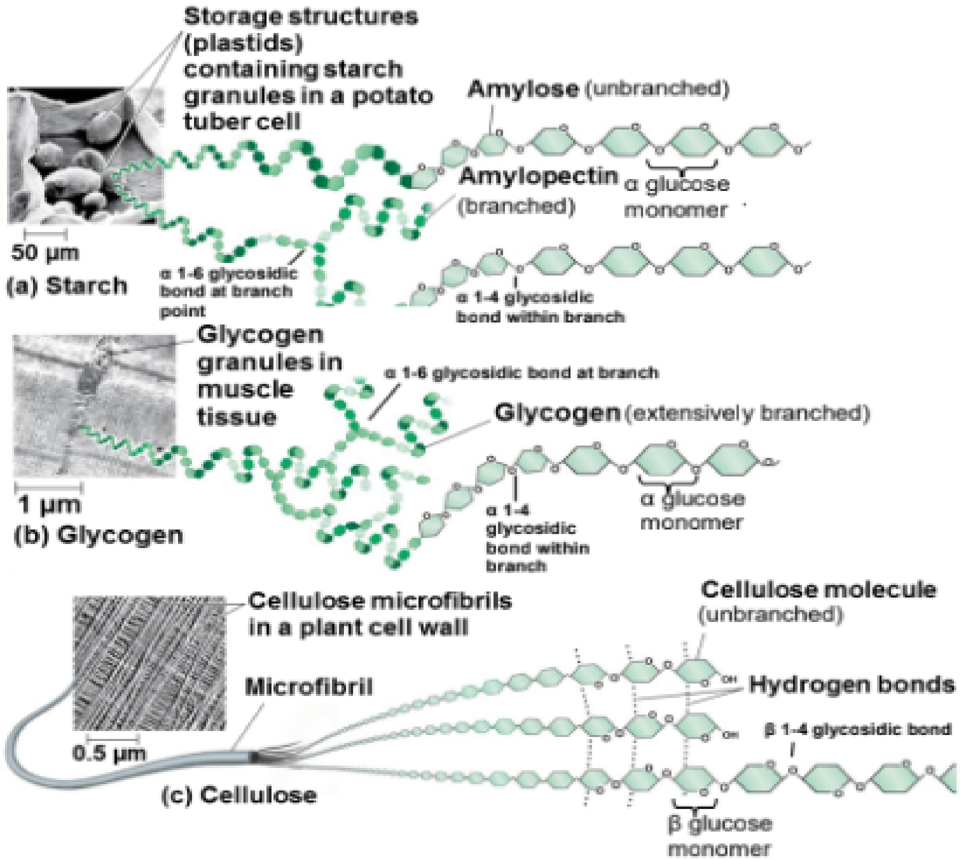
→ made up of 2 monosaccharides joined by a glycosidic bond formed between 2 monosaccharides by a condensation reaction that involves the loss of a water molecule

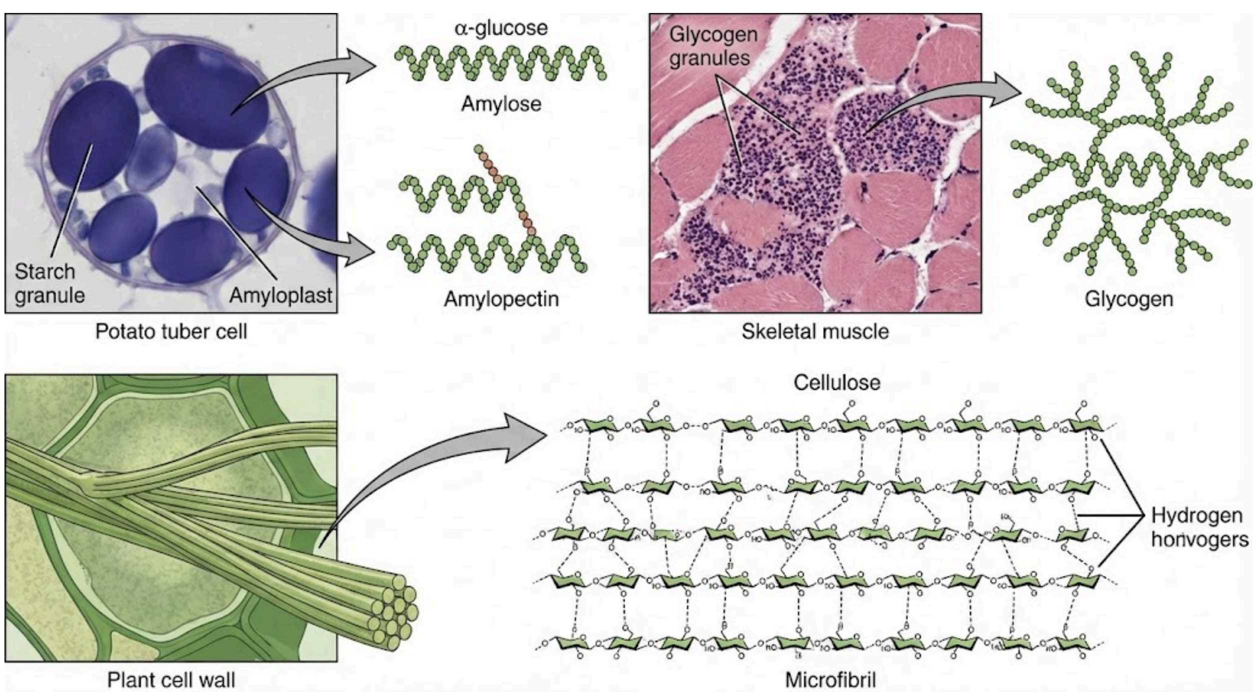
→ can be split back into their component monosaccharides via hydrolysis reaction where, with the addition of one molecule of water, the glycosidic bond can be broken

→ have many hydroxyl groups (-OH) which extend out of the ring which can form hydrogen bonds with water ;
Readily soluble in water!</td></tr>
<tr><td colspan="2">Polysaccharides: $\mathbf{(C_6H_{10}O_5)_n}$ → made up of many monosaccharides joined via glycosidic bonds formed between them by condensation reactions involving the loss of water molecules</td></tr>
</table>

Polysaccharide	Starch	Glycogen	Cellulose
Function	**Plant storage** polysaccharide	**Animal storage** polysaccharide	**Plant structural** polysaccharide
Location	Stored as **granules** in **chloroplasts**	Stored in **liver** and **muscle cells**	**Cell walls** of plant cells
Monomer	Made up of **α-glucose** monomers	Made up of **α-glucose** monomers	Made up of **β-glucose** monomers
Bond between monomers	In **amylose**: **α(1-4) glycosidic bond** links monomers; In **amylopectin**: **α(1-4) glycosidic bond** links monomers within a branch and **α(1-6) glycosidic bonds** links monomers at branch points	**α(1-4) glycosidic bond** links monomers **within a branch** and **α(1-6) glycosidic bonds** links monomers **at branch points**	**β(1-4) glycosidic bond** links monomers in a molecule
Orientation of monomer	All glucose monomers in the chain have the **same orientation**	All glucose monomers in the chain have the **same orientation**	Alternate β glucose monomers **rotated 180°** with respect to each other
Structure of each molecule	**Amylose** is a **helical** molecule while **amylopectin** is a **helical and branched** molecule	**Helical and branched** molecule, like amylopectin, but **more extensively branched**	**Long, straight chain**
Bonds between molecules	No **interchain** hydrogen bonding	No **interchain** hydrogen bonding	**-OH groups projecting outwards** in **both directions** allow **interchain** hydrogen bonding between parallel chains ➔ forming **microfibrils**

How the structures of starch and glycogen make them good <u>STORAGE</u> molecules	**How the structure of cellulose makes it a good <u>STRUCTURAL</u> molecule**
1. Made up of many **α-glucose monomers** that **coil** to form **helices** - Hence is a **large yet compact energy store** as many **α-glucose monomers** can be packed **per unit volume** - Hence **most -OH group**s are involved in **intramolecular hydrogen bonding within the helix** and **few -OH groups** available for **hydrogen bonding** with water. → Hence **starch/glycogen** is **insoluble in water** and the **osmotic potential** of cells are **unaffected** by its presence. 2. Amylopectin and glycogen are **branched** - Thus they have **multiple branch ends** which **hydrolytic enzymes** can work on. Hence **more glucose molecules** can be **released at the same time** and **more ATP** can be generated by respiration **per unit time**.	1. **Adjacent glucose units** are **inverted 180°** with respect to each other and hence form a **long, linear, unbranched** molecule with free **-OH groups projecting out in both directions** which can **hydrogen bond** with **-OH groups** of other cellulose molecules lying **parallel** to it and form **microfibrils**. - Hence **microfibrils** have **high tensile strength**. 2. As a **macromolecule**, cellulose has **few -OH groups available** to **hydrogen bond** with water as most are involved in **interchain hydrogen bonding**. Thus only the **surface of the microfibril** has **-OH groups** that can **hydrogen bond** with water. - Hence cellulose is **insoluble in water** and the **osmotic potential** of cells are **unaffected** by its presence. 3. The **meshwork of microfibrils** that form the **cell wall** - have a **porous structure** and hence the cell wall is **freely permeable to water and solutes** and allows **movement of substances** across the cell wall. - are **strong and rigid** and **distributes stress in all directions** to **prevent** the plant cells from **bursting due to osmotic stress**. 4. **Cellulases** that **hydrolyse** cellulose are **found in very few** organisms. Thus cellulose cannot be **hydrolysed** and used as a **respiratory substrate** and is a **good structural molecule**.


Storage structures (plastids) containing starch granules in a potato tuber cell
Amylose (unbranched)
Amylopectin (branched)
α glucose monomer
50 μm
(a) Starch
α 1-6 glycosidic bond at branch point
α 1-4 glycosidic bond within branch
Glycogen granules in muscle tissue
α 1-6 glycosidic bond at branch
Glycogen (extensively branched)
1 μm
(b) Glycogen
α 1-4 glycosidic bond within branch
α glucose monomer
Cellulose microfibrils in a plant cell wall
Cellulose molecule (unbranched)
Microfibril
Hydrogen bonds
β 1-4 glycosidic bond
0.5 μm
(c) Cellulose
β glucose monomer


α-glucose
Amylose
Amylopectin
Starch granule
Amyloplast
Potato tuber cell
Glycogen granules
Skeletal muscle
Glycogen
Cellulose
Hydrogen horivogers
Plant cell wall
Microfibril