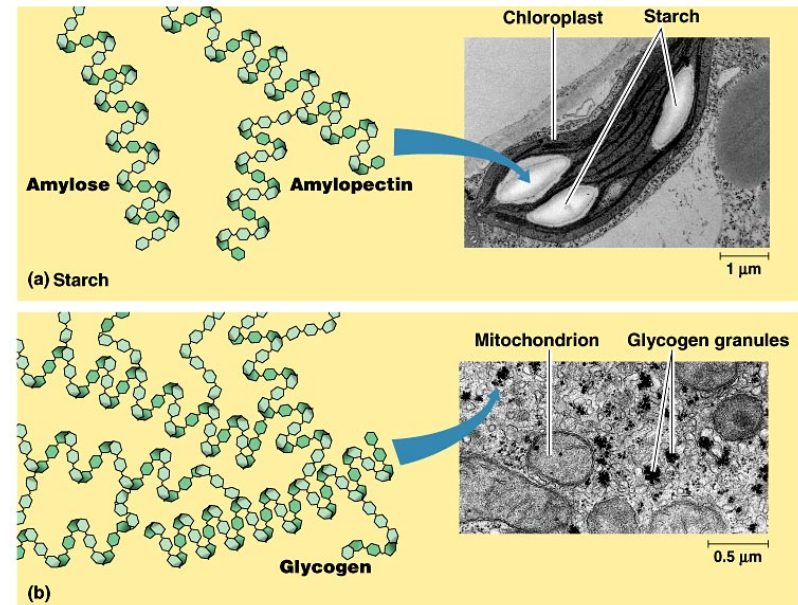


BI107 CHAP 5

Structure and Function of Macromolecules

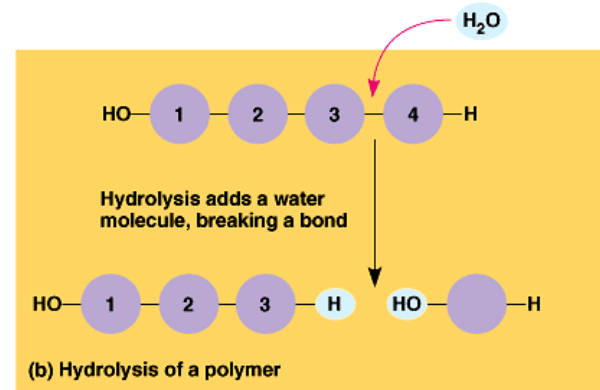
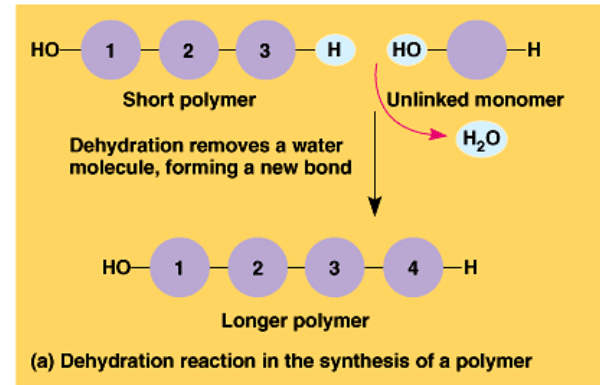
Polymer Principles

- Macromolecule types such as carbohydrates, proteins, nucleic acids are made from small building blocks but the large molecules are called polymers which are long molecules consisting of many similar or identical building blocks (monomers) linked by covalent bonds



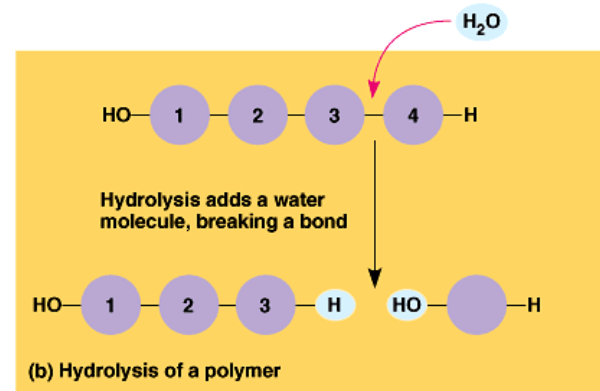
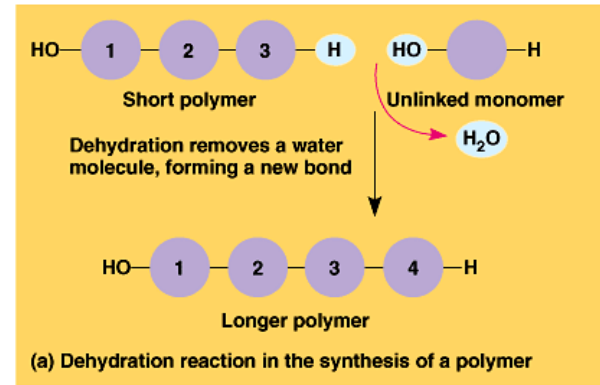
Polymer Principles cont.

- Different polymers made from different sets of monomers but the way polymers are built up or broken down is the same for different polymers



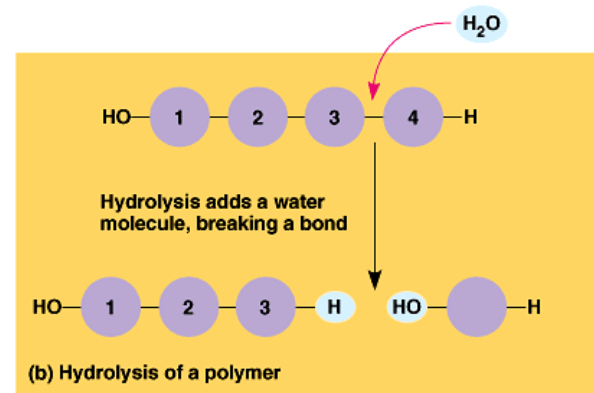
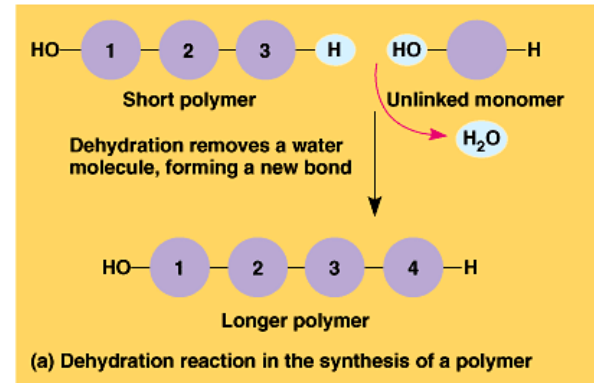
Polymer Principles cont.

- Polymer buildup called a condensation reaction specifically a dehydration reaction where monomer linked to monomer by loss of water
- Hydrogen (-H) removed from 1 monomer and linked to hydroxyl (-OH) removed from 2nd monomer to form water and 2 monomers linked



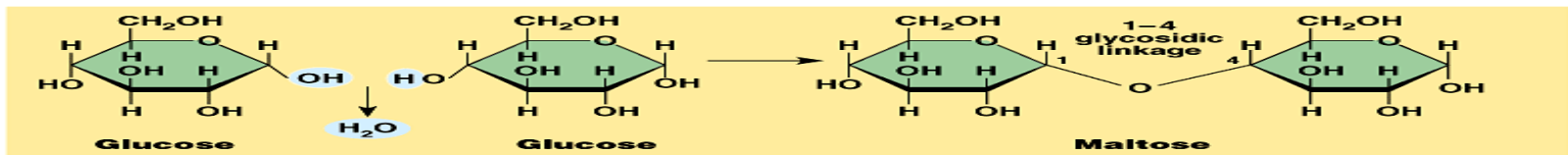
Polymer Principles cont.

- Polymers broken down to monomers by process of hydrolysis – reverse of dehydration – where bonds broken by addition of water molecule which is broken and the hydrogen goes to 1st monomer and the hydroxyl is added to the 2nd monomer - digestion involves polymer breakdown

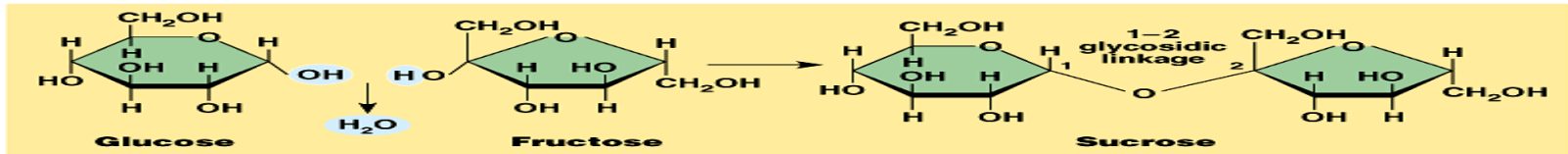


carbohydrates

- Sugars and polymers of sugars
- Single sugars called monosaccharides or simple sugars
- Double sugars called disaccharides – 2 monosaccharides joined by condensation reaction



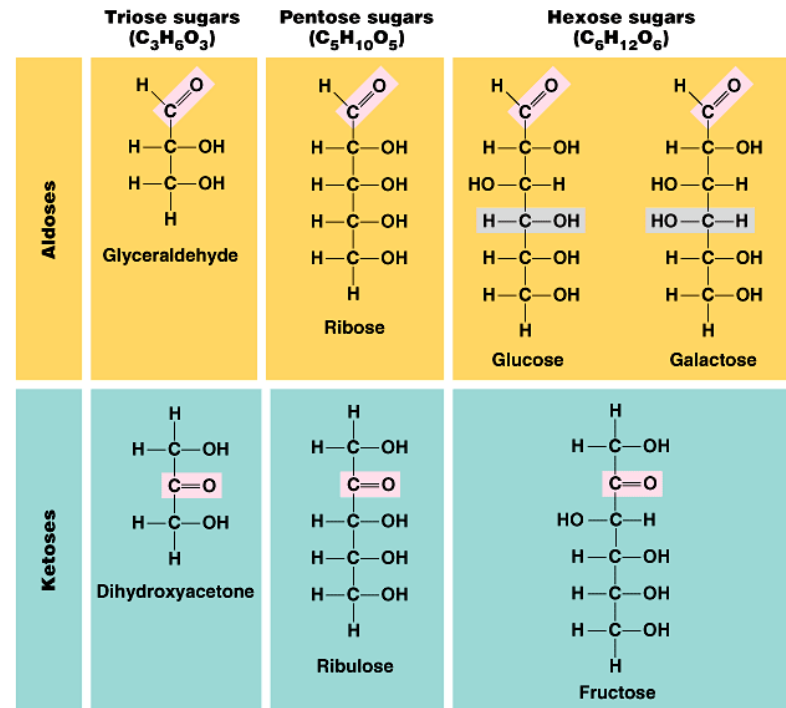
(a) Dehydration synthesis of maltose



(b) Dehydration synthesis of sucrose

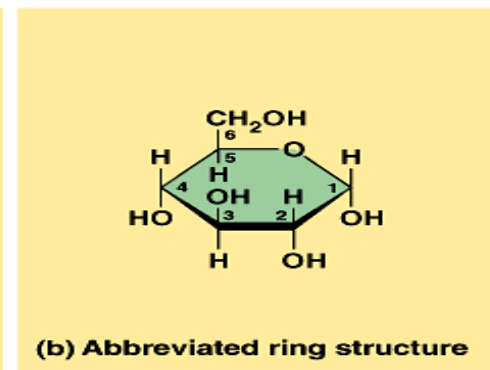
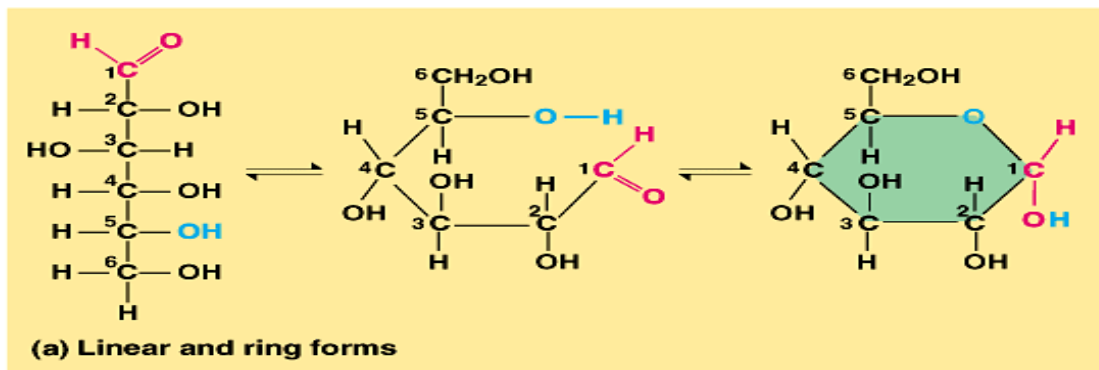
Carbohydrates cont.

- Monosaccharides usual structure is a multiple of (CH_2O)
- Has a carbonyl group and multiple hydroxyl groups & when carbonyl is on end of molecule molecule called aldose and when carbonyl is inside gives a ketose (glucose – aldose but structural isomer fructose is a ketose)



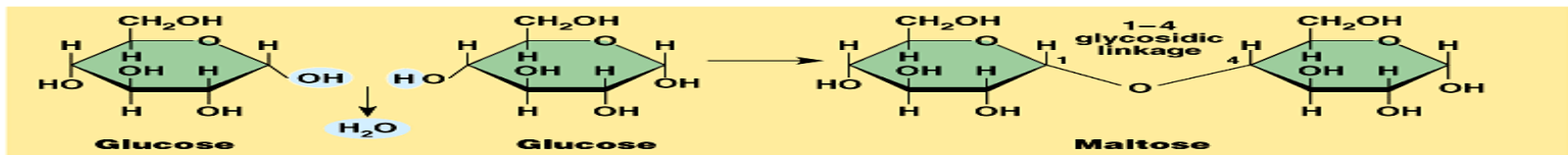
Carbohydrates cont.

- Length of carbon skeleton is variable so get different sugars based on length with 6, 3, and 5 carbon sugars being common
- In solution most sugars found in ring form not linear form but reaction is reversible with an open ring intermediate

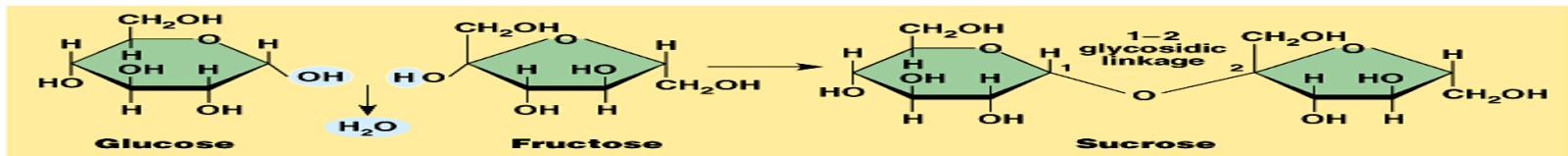


Carbohydrates cont.

- Monosaccharides esp. glucose used for energy but can be used to make other small organic molecules or incorporated as monomers into disaccharides or polysaccharides



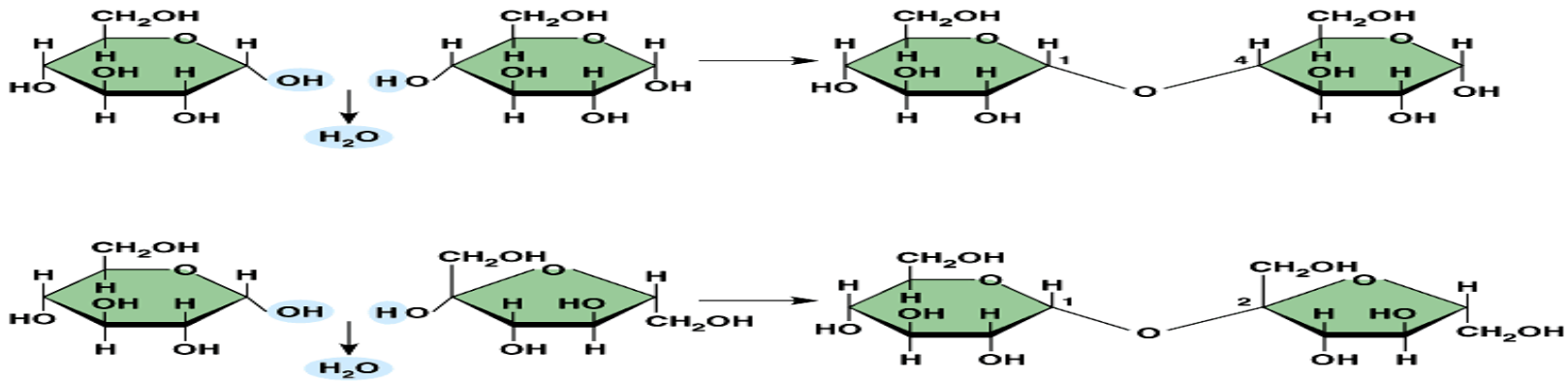
(a) Dehydration synthesis of maltose



(b) Dehydration synthesis of sucrose

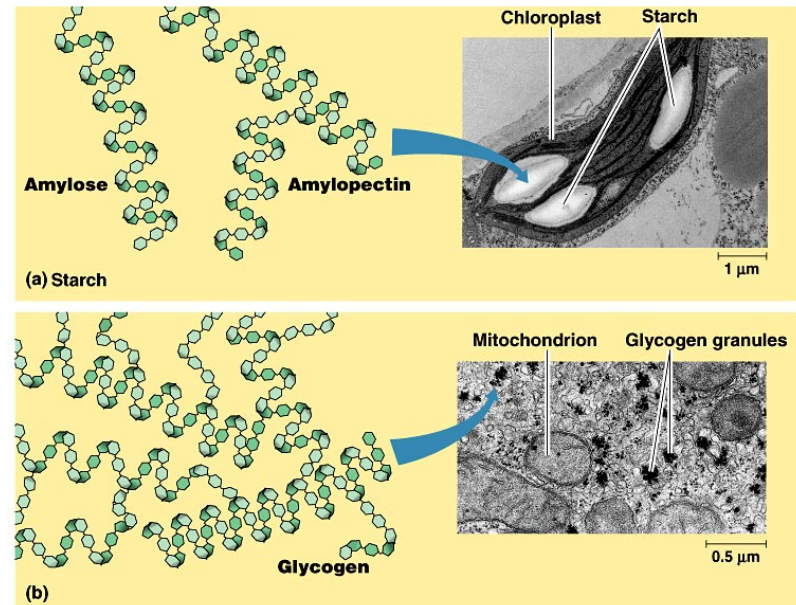
Disaccharides

- 2 monosaccharides joined by glycosidic link in dehydration reaction
- Maltose – 2 glucose with 1,4 glycosidic link but sucrose – 1 glucose (6 carbon ring) & 1 fructose (6 carbon but 5 carbon ring) with 1,2 glycosidic link



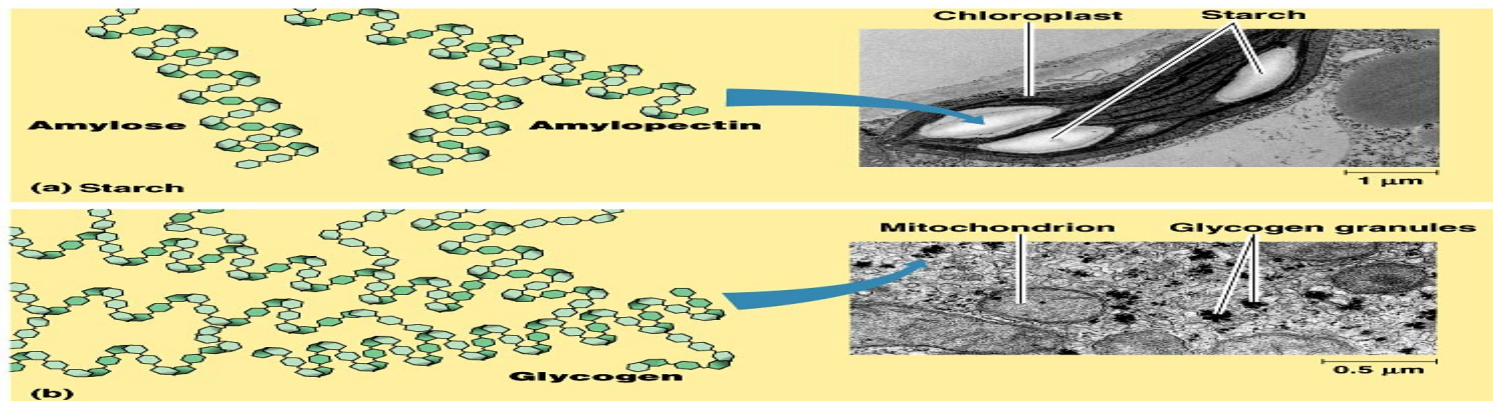
Polysaccharides

- Macromolecules with hundreds to thousands of monosaccharides joined by glycosidic links
- Polysaccharides used for storage and for structure



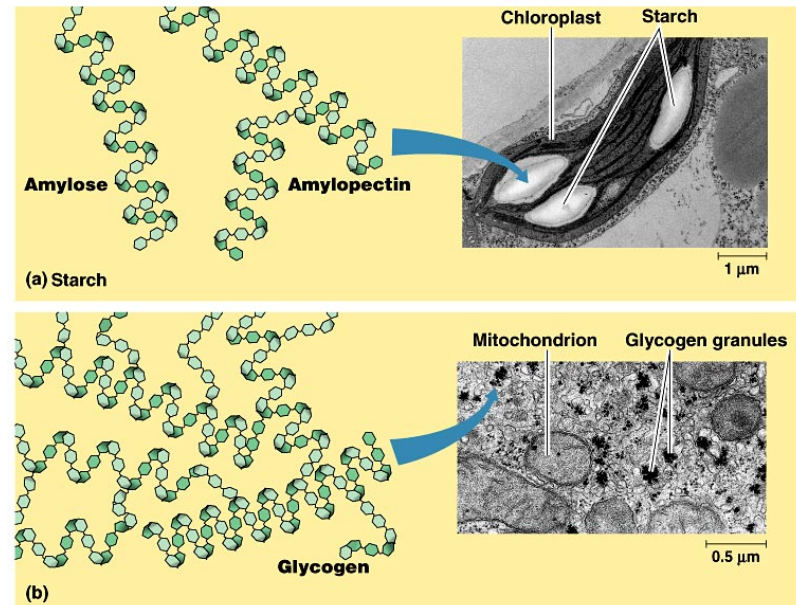
Polysaccharides cont.

- Polysaccharides used for storage – starch is plant storage of glucose monomers linked by 1,4 glycosidic link of alpha glucose monomers
- Starch stored as granules within structures called plastids including chloroplasts
- 2 forms – amylose (unbranched) & amylopectin (branched)



Polysaccharides cont.

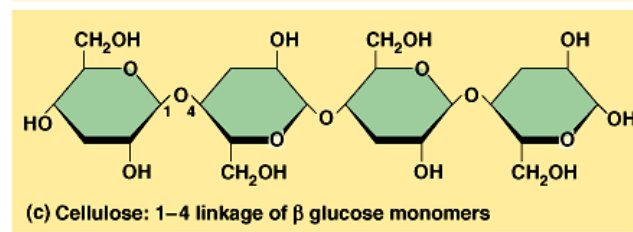
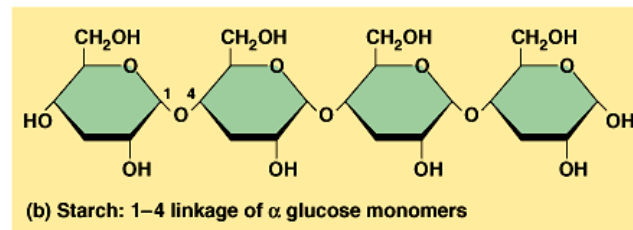
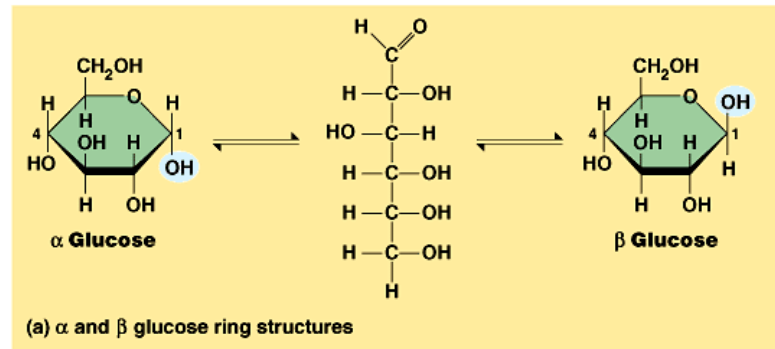
- Animal storage of glucose is in form of glycogen which is similar to amylopectin in plants but is more extensively branched
- Stored in liver and muscle and glucose released by hydrolysis



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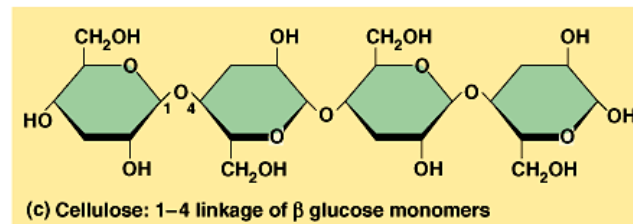
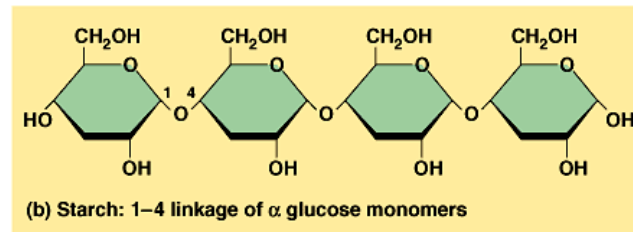
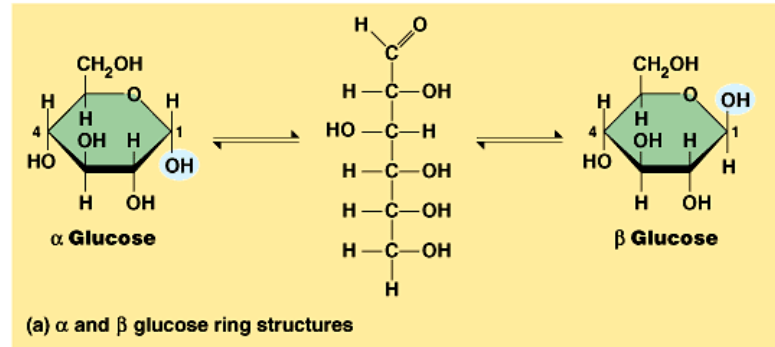
Polysaccharides – Structural Molecules

- Cellulose – cell wall of plants – most abundant organic material on earth – 100 billion tons produced/yr
- Polymer of glucose but glycosidic link is different than in starch



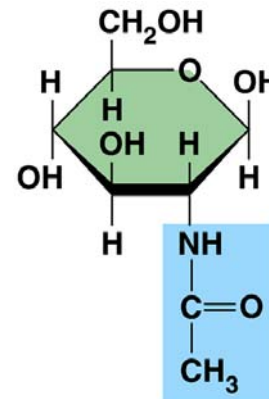
Polysaccharides – Structural Molecules cont.

- 2 alternate ring forms of glucose exist – hydroxyl on carbon 1 can be above (beta) or below (alpha) the plane of the ring
- In starch all glucose molecules in alpha position and in cellulose all glucose molecules in alpha position only some bacteria have the enzyme needed to digest cellulose – in stomach of cow or termite



Polysaccharides – Structural Molecules cont.

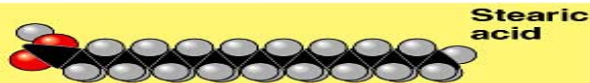
- Chitin – exoskeleton of arthropods – insects, spiders, crustaceans – hardens when encrusted with calcium carbonate
- Also found in fungi which use it in cell wall in place of cellulose
- Glucose momomer has a nitrogen containing appendage



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Lipids

- Do not have monomers & main property is dislike of water so called hydrophobic
- Consist mostly of hydrocarbons



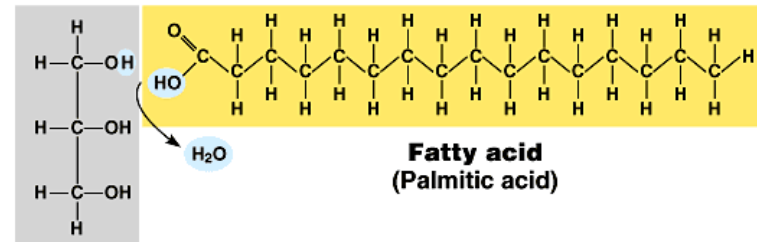
(a) Saturated fat and fatty acid



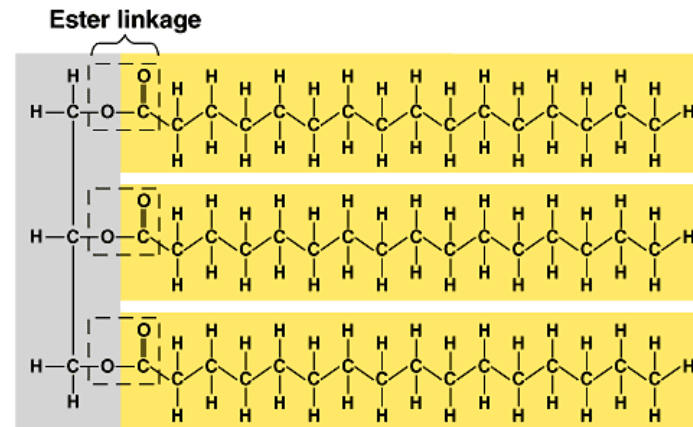
(b) Unsaturated fat and fatty acid

Lipids cont.

- Fats – assembled from glycerol and 3 fatty acid chains by dehydration reaction
- Fatty acid chain varies in length (12-24 carbons) with carboxyl group at one end giving acid designation
- Long chains of fatty acids are reason molecules are hydrophobic



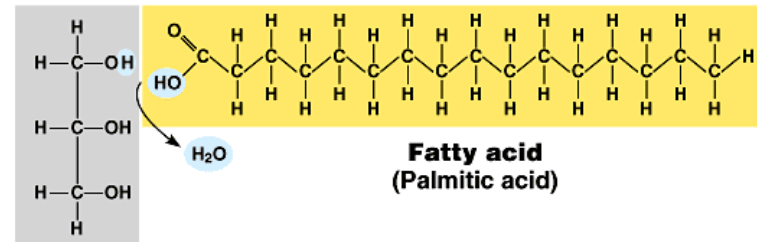
Glycerol
(a) Dehydration synthesis



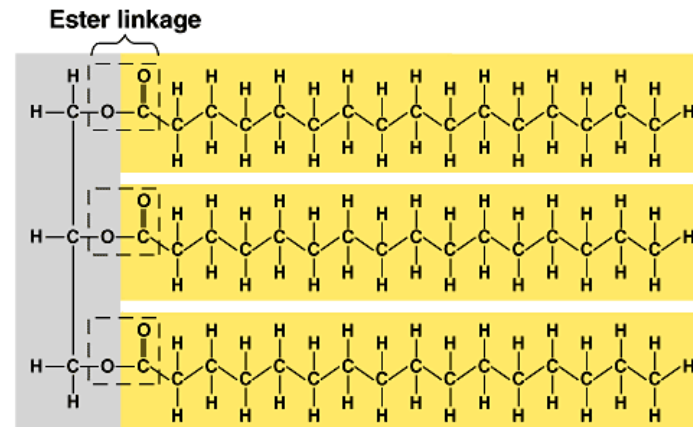
(b) Fat molecule (triacylglycerol)

Lipids cont.

- 3 fatty acid chains join a glycerol molecule by ester linkage – bond between hydroxyl group and carboxyl group – gives a triglyceride with fatty acid chains same or different lengths



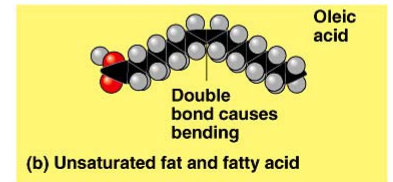
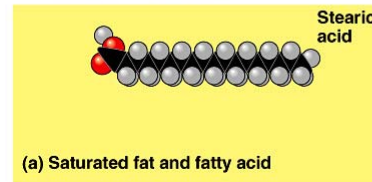
Glycerol
(a) Dehydration synthesis



(b) Fat molecule (triacylglycerol)

Lipids cont.

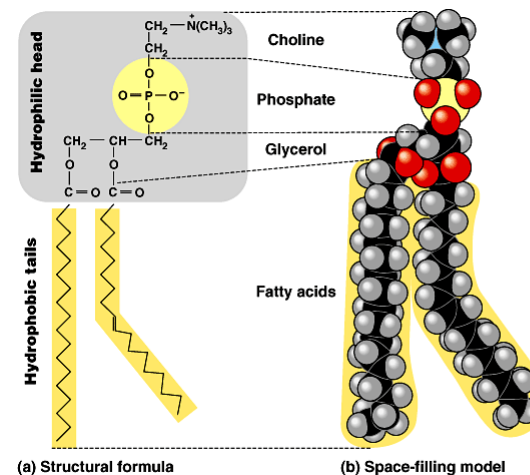
- Fatty acid chains can have all single bonds (called saturated fats & come from animals) or can have some double bonds (unsaturated [mono or poly] & come from plants)
- Saturated fats are solids and unsaturated are liquids at room temperature



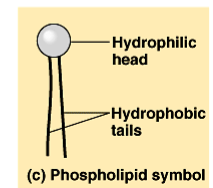
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Lipids - Phospholipids

- Phospholipids are components of cell membranes forming a phospholipid bilayer
- Has distinct properties – part hydrophobic (fatty acid chains) & part hydrophilic (charged phosphate group)
- A group usually attached to the phosphate group



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Lipids - Steroids

- Carbon skeleton consists of 4 fused rings with different functional groups
- Cholesterol is common in cell membranes & is precursor of lipid soluble hormones such as sex hormones

