

Chapter 3

Macromolecules: their chemistry and biology

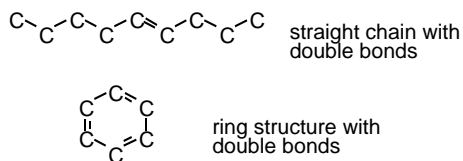
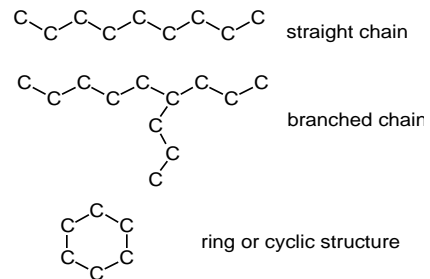
Terms

- ✓ Macromolecules - large molecules - usually polymers
- ✓ Polymers - small units linked together
- ✓ Monomers - single units
- ✓ Organic - carbon containing

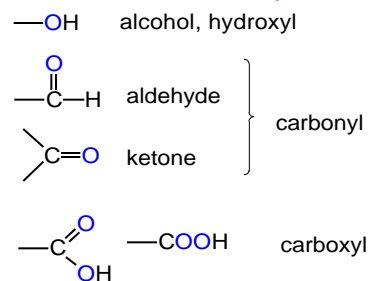
4 Biologically important macromolecules

- ⇒ **Lipids** -- fats, oils, waxes
- ⇒ **Carbohydrates** -- starch, cellulose, chitin, glycogen
- ⇒ **Nucleic acids** -- DNA, RNA, ATP
- ⇒ **Proteins** -- silk, hair, tendons, Jell-O

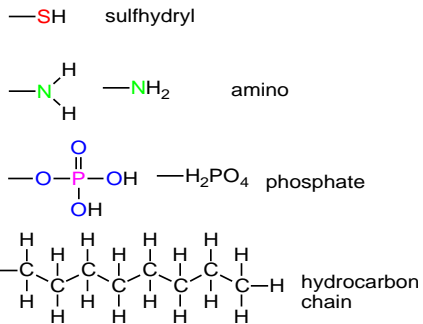
Carbon skeletons



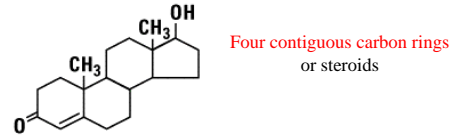
Functional Groups



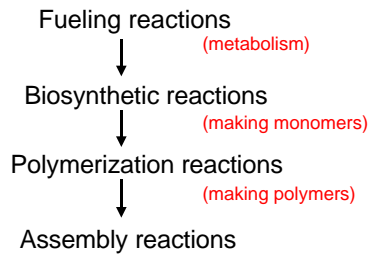
Functional Groups (cont.)



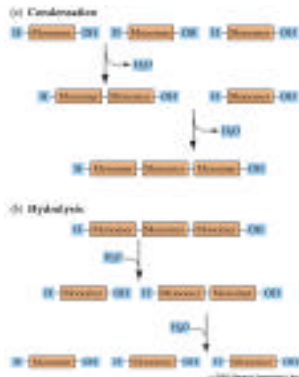
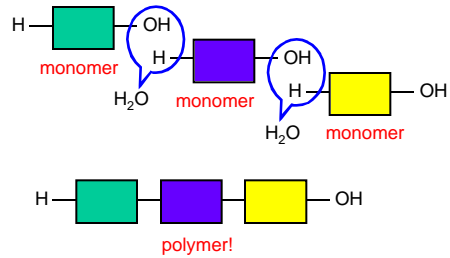
Functional Groups (cont.)



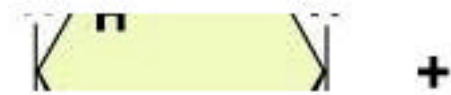
Biological Reactions



Monomers to Polymers



Monomers to polymers



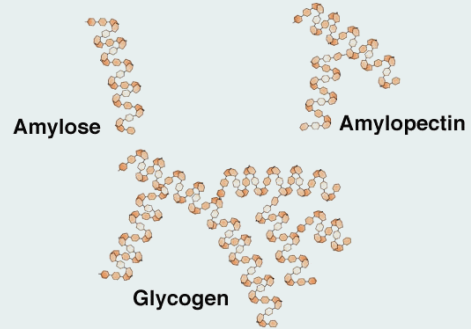
The disaccharide table sugar

Biological Molecules

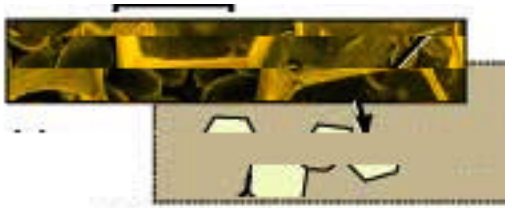
monosaccharides → polysaccharides
 fatty acids and glycerol, sterols → lipids
 nucleotides → nucleic acids
 amino acids → proteins

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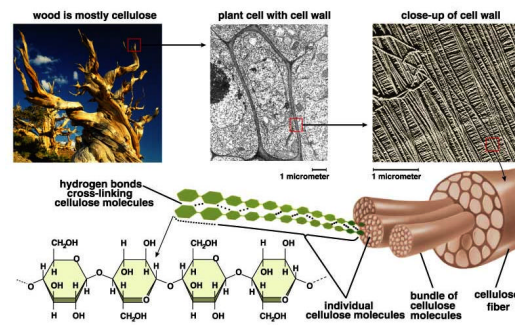
Starches



Starch molecules

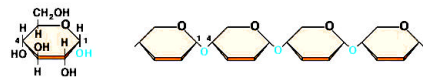


Cellulose molecules

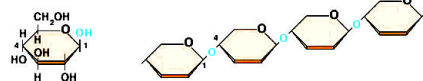


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Comparison of Starch and Cellulose



Starch: chain of α glucose subunits

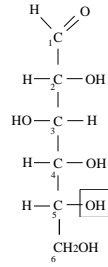


Cellulose: chain of β glucose subunits

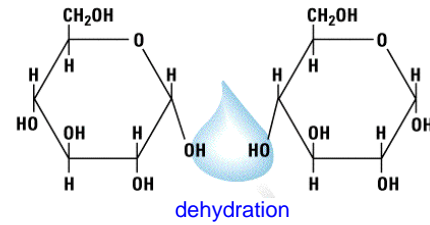
Chitin - N-acetylglucosamine



Carbohydrates



Glycosidic bonds are formed in a dehydration reaction between 2 carbohydrates.



Carbohydrates

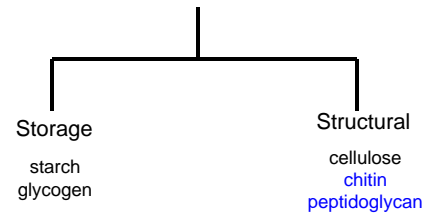
✓ Monomers

- glucose
- fructose
- ribose and deoxyribose

✓ Polymers

- starch
- glycogen
- chitin
- peptidoglycan

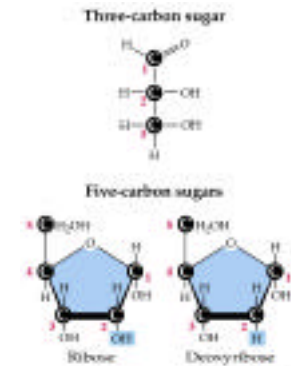
Carbohydrate Families



Isomers of glucose (6 carbon sugars)



Other sugars

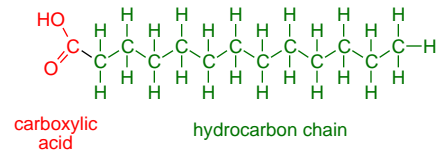


5 carbon sugars



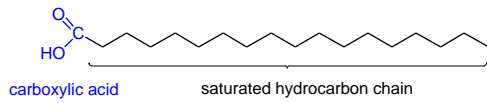
Fatty acids

✓ Carboxyl functional group attached to a hydrocarbon chain.



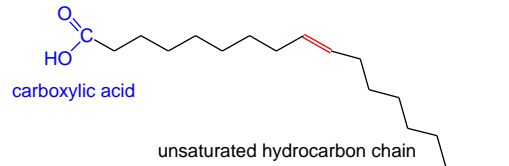
Saturated fatty acid

stearic acid--a saturated fatty acid

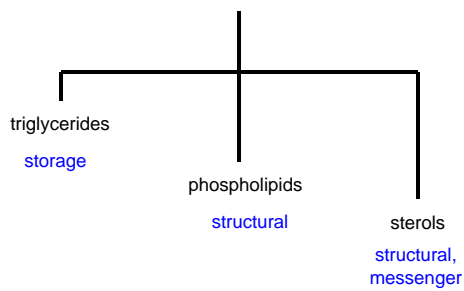


Unsaturated fatty acid

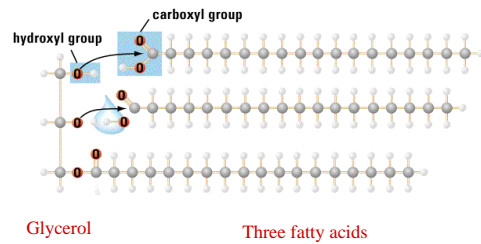
oleic acid--an unsaturated fatty acid



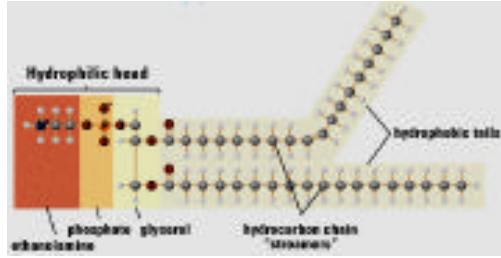
Lipid families



Triglycerides



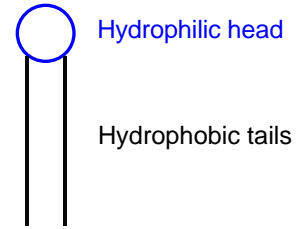
Phospholipids



Phosphate group

2 fatty acids

Phospholipids are amphipathic molecules



Hydrophilic head

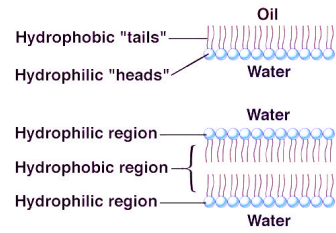
Hydrophobic tails

Phospholipids form micelles and bilayers



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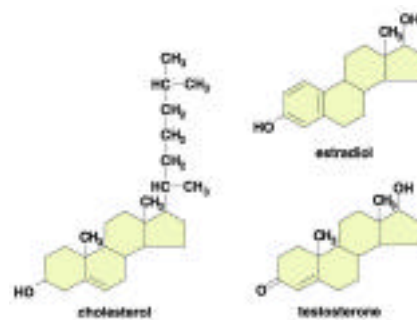
Phospholipids



Lipids



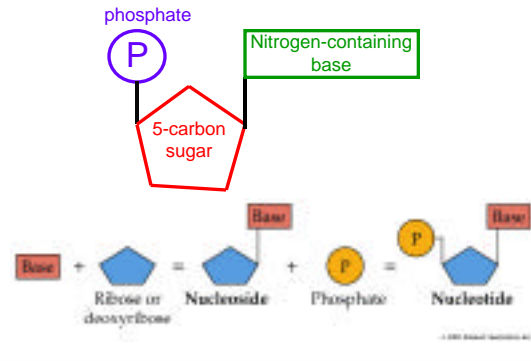
Steroids Steroids contain 4 rings of carbon atoms



Others include: progesterone & corticosterone

Nucleic Acids and Proteins

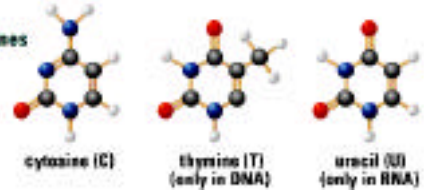
Basic structure of a nucleotide



Nucleotides Purines



Pyrimidines

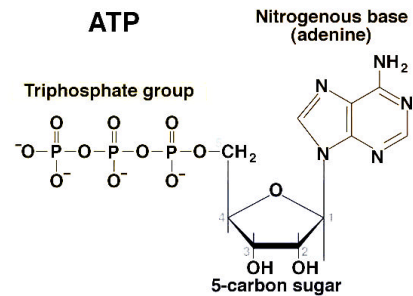


Ribose vs deoxyribose

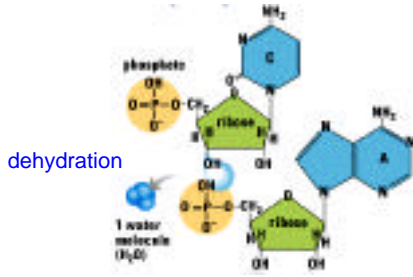


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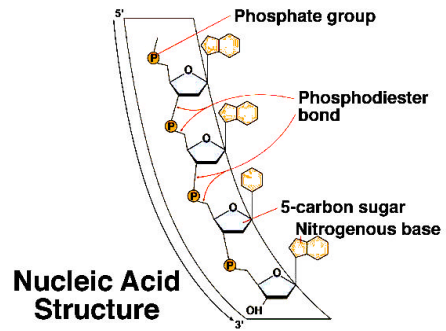
ATP



Nucleotides to Nucleic Acids

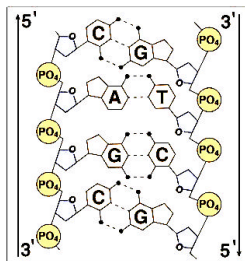


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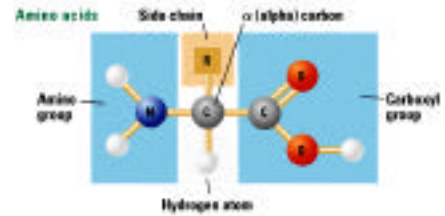


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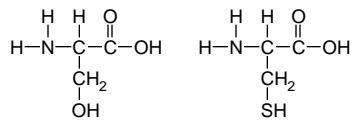
DNA Base-Pairing and Hydrogen Bonds



Basic structure of an amino acid



Polar, non-ionizable amino acids or polar but uncharged

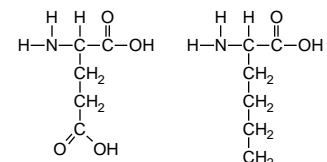


serine

cysteine

Contain alcohol (-OH) Contain sulfhydryl (-SH) groups
& form disulfide bridges

Polar, ionizable (charged) amino acids

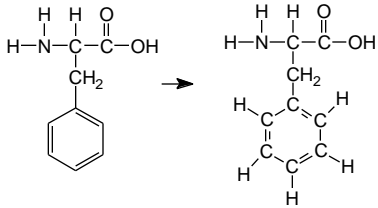


glutamic acid

lysine

Contain carboxyl (-COOH) and amino (-NH₂) groups

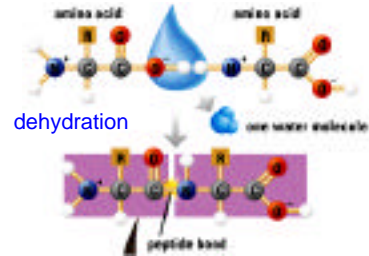
Nonpolar (hydrophobic) amino acids



Phenylalanine

Contain only carbon (C) and hydrogen (H) atoms

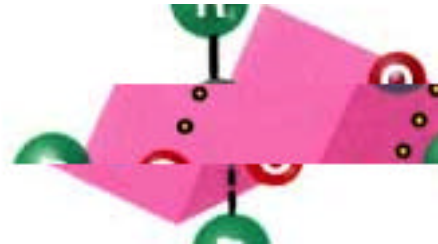
Amino Acids to Proteins



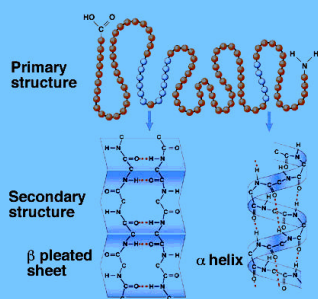
Protein Structure

- ✓ Primary
 - Linear arrangement of amino acids.
- ✓ Secondary
 - 3-dimensional α -helix and β -pleated sheet.
- ✓ Tertiary
 - Hydrophobic, ionic interactions, disulfide bonds
- ✓ Quaternary
 - Two or more polypeptides forming a functional protein.

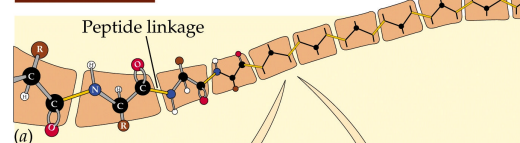
β -pleated sheet



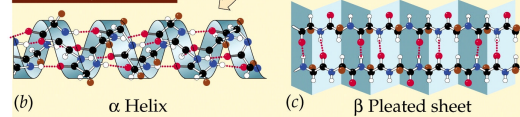
Levels of Protein Structure (1)



Primary structure



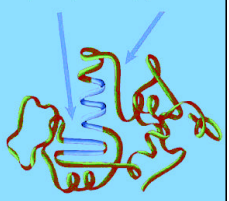
Secondary structure



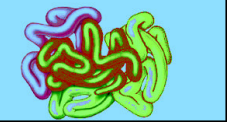
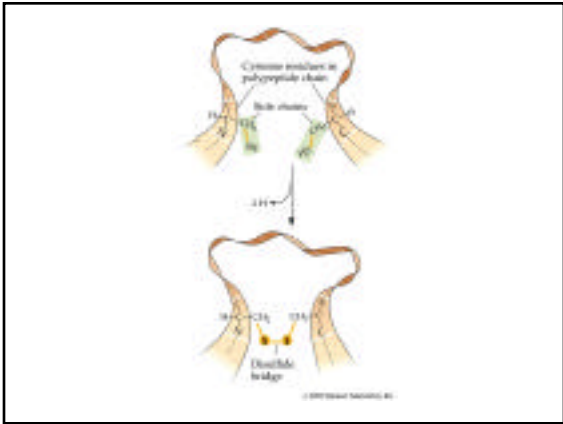
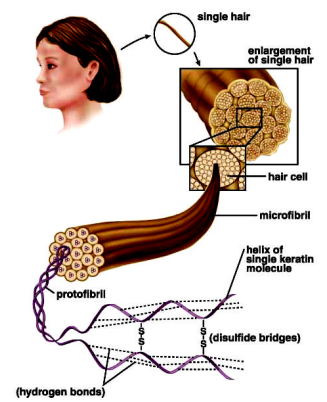
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Levels of Protein Structure (2)

Tertiary structure



Quaternary structure

single hair

enlargement of single hair

hair cell

microfibril

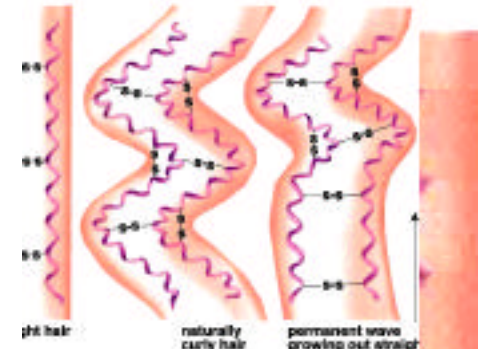
protofibril

helix of single keratin molecule

(disulfide bridges)

(hydrogen bonds)

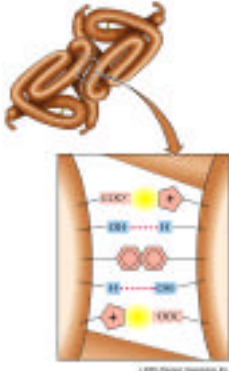
Straight versus curly hair



flat hair

naturally curly hair

permanent wave growing out straight



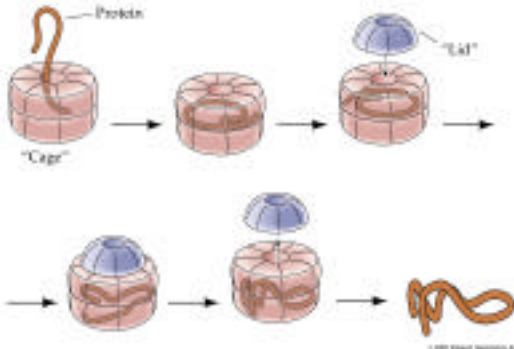
Non-covalent protein interactions

Salt bridges

Hydrogen bonds

Hydrophobic interaction

Chaperonin proteins



Protein

"Cpr"

"Cap"

The End



First Contact