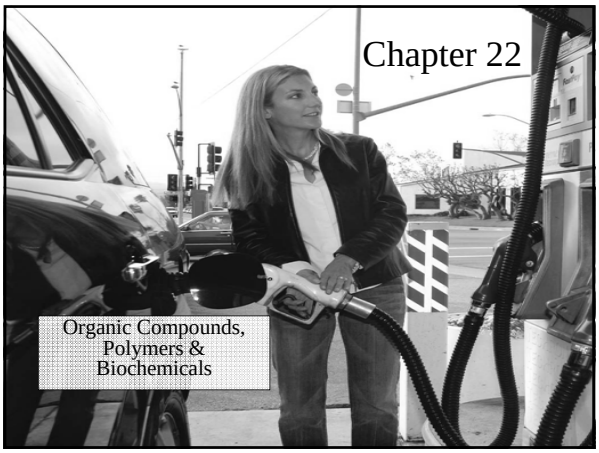


22.1 Organic Chemistry

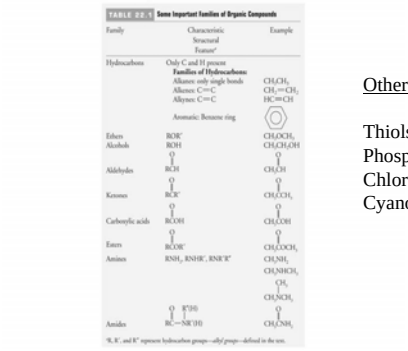
- The study of the compounds of carbon, not classified as inorganic
  - Plastics, fibers, dues, drugs, insecticides, perfumes, petroleum products, etc…
- Carbon atoms
  - Form 4 covalent bonds
  - Bond with each other
  - Are able to make long chains

2

Functional Groups

- **Functional groups** – small structural units within a molecule at which most of the compound's reactions occur
- Define organic families
- Functional groups are only a part of an organic molecule.
- *R* (and *R'*) – represents the unimportant part of the molecule that does not react,
  - Can be organic fragment containing carbon atoms
  - Sometimes, a hydrogen atom

3



Others not in the table

Thiols	RSH
Phosphates	R-OPO_3
Chloro	R-Cl
Cyano	R-CN

You should be able to recognize functional groups and name them. See practice handout. 4

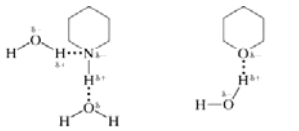
Functional Groups and Solubility

- The functional groups and size, determine if a molecule is soluble in water.
- "likes dissolve likes"
- Hydrocarbons are nonpolar and tend to be insoluble in water (a polar solvent).
- These include alkanes, alkenes and alkynes.
- Molecules can have a mixture of polar and nonpolar structures.

5

Solubility and Forces

- Molecules with polar functional groups tend to be soluble in water.
- Alcohols, carboxylic acids, amines, and amides
- How?
- Hydrogen bonding!



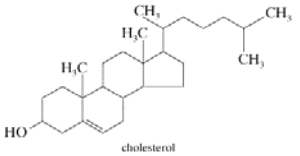
piperidine hydrogen-bonded to two water molecules

tetrahydropyran hydrogen-bonded to a water molecule

6

Solubility and Size

- Large molecules, even if they contain polar functional groups, tend to be insoluble.



cholesterol

7

We are skipping 22.2 – 22.6.

22.6 Most biochemicals are organic compounds

- Biochemistry is the systematic study of the chemicals of living things.
- Living things are composed mostly of organic compounds.
- Living systems require:
  - Materials (lipids)
  - Energy (lipids and carbohydrates)
  - Information or "blueprints" (proteins and nucleic acids)

8

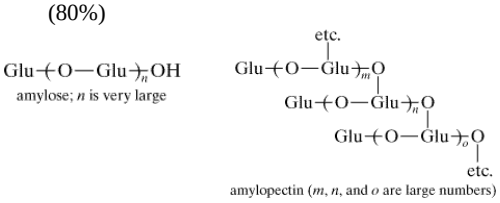
22.7 Carbohydrates

- Carbohydrates are monomers and macromolecules with empirical formulas of $C_x(H_2O)_y$ where x and y are integers.
- "hydrated carbon"
- Important food source for most organisms
- **Monosaccharides:** small molecules that when broken down provide quick energy for cells (sugar high)
  - Glucose, sucrose, fructose
- **Polysaccharides** – macromolecular carbohydrates that store large amounts of energy
  - Starch, glycogen and cellulose

9

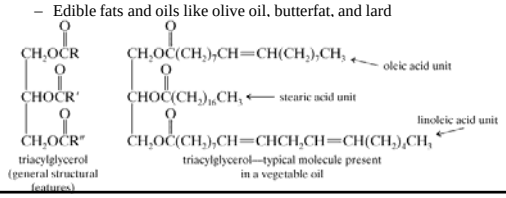
Polysaccharides

- Starch: polymers of glucose (Glu)
  - where plants store energy
  - two types: Amylose (20%) and Amylopectin (80%)



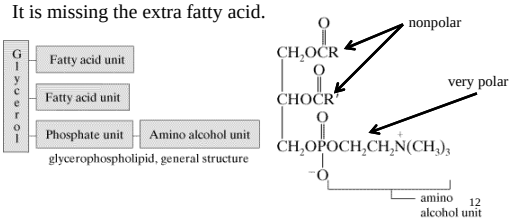
Lipids comprise a family of water-insoluble compounds

- Very large group of molecules.
- Only requirement is that **hydrocarbons compose a large portion of the molecule**
- Triacylglycerols are <u>one type</u> of lipid.
  - Esters between glycerol and three long chain **fatty acids**
  - Edible fats and oils like olive oil, butterfat, and lard



Lipids and Cell Membranes

- **Glycerophospholipids** - lipids involved in animal cell membrane
- Composed of (a) glycerol, (b) 2 fatty acids and (c) a phosphate unit attached to an amino-alcohol unit
- It is missing the extra fatty acid.



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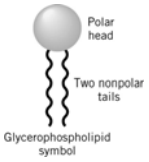
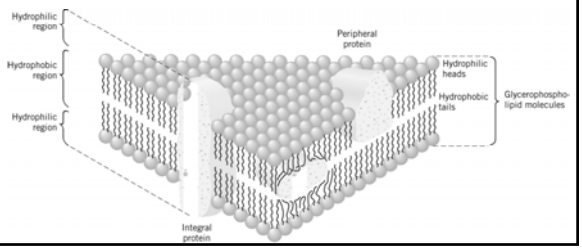
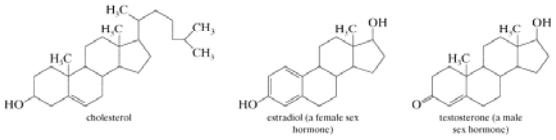
- Large molecules that have a polar end and a nonpolar end.
- The nonpolar end (**tail**) is **hydrophobic.**
- The polar end (**head**) is **hydrophilic.**





Will they dissolve in water?



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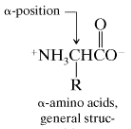
Proteins are polymers of amino acids.

- The most important biochemicals in cells are proteins (enzymes, antibodies, hormones, transport molecules, and structural materials)
  - Protect organisms from disease
  - Extract energy from food
  - Move essential cellular components
  - Responsible for vision, taste and smell
  - Etc…
  - Proteins are the molecular machinery of the cell.
- Macromolecules called **polypeptides.**
- Monomer components are from a set of 20 **amino acids**.

15

Amino Acids

- Building blocks of polypeptides
- All have 2 functional groups: amine and carboxylic acid.
- They are identified by their "R" group.



R = H, glycine (Gly)
= CH_3, alanine (Ala)
= CH_2–C$_6$H$_5$, phenylalanine (Phe)
= $CH_2CH_2CO_2H$, glutamic acid (Glu)
= $CH_2CH_2CH_2CH_2NH_2$, lysine (Lys)
= CH_2SH, cysteine (Cys)

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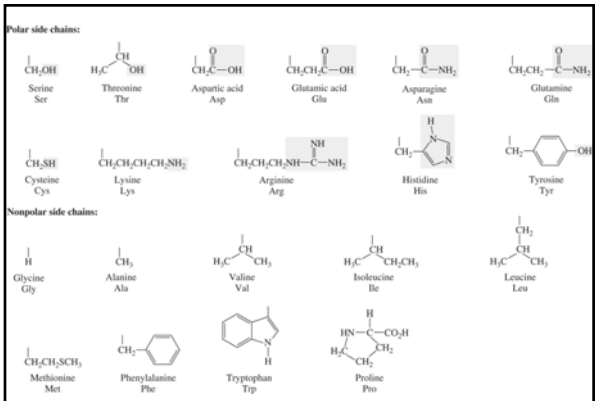
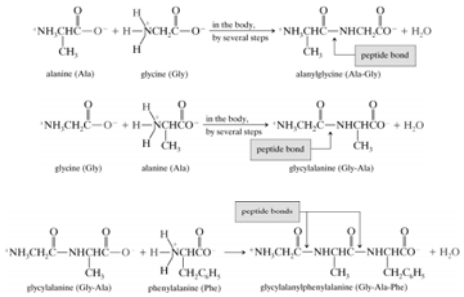


Under the name of each amino acid is its three-letter abbreviation.

17



- Amino acids condense to create a **peptide bond**.
- Use three letter abbreviation for the amino acids.
- The terminal amine group in a polypeptide is always written on the **left** and the terminal carboxylic acid is always written on the **right**.

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Circle the amine terminus and put a square around the carboxylic acid terminus.

Gly – Ser – Glu – Phe – Phe – Lys – Lys – Lys

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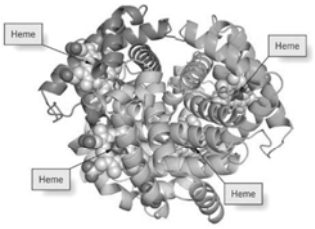
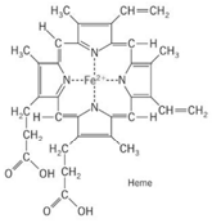
Proteins

- Some proteins consist of a single polypeptide chain (a long molecule).
- MOST proteins are mixtures of two or more polypeptides (two ore more long molecules).
- And in some proteins the polypeptides are identical.
- Proteins may also include small organic molecules and metal ions in their structure.

20





- Hemoglobin – example of a protein with 4 polypeptide chains and the Heme molecule that imparts the red color of blood.
- Notice the iron(II) in the middle of Heme molecule.

21

Protein Shape

- The final shape of a protein, called its **native form**, is critical to its ability to function.
- Physical agents such as heat, poisons, and certain solvents can alter a proteins native form.
  - When this happened the protein is said to have been **denatured.**
  - It loses it's shape.
- A change in pH can radically alter the ability of a protein to function.
- Therefore, it is very important that body pH be stable.

22

22.8 Nucleic Acids

- The instructions for self-replication in biological organisms is stored and transmitted by macromolecules called nucleic acids.
- Genetic information is stored in molecules of DNA (deoxyribonucleic acid), located in the cell nuclei. (MM > 10^9 g/mol)
- The information stored in DNA is transmitted by RNA (ribonucleic acid). (MM = 20,000 – 40, 000 g/mol)

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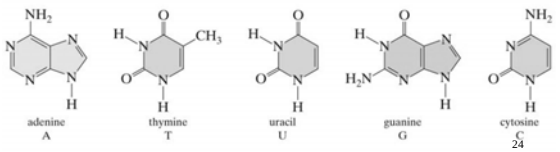
Nucleotides

Nucleotides: - the building blocks of nucleic acids, require 3 components

1. A nitrogen containing organic base
   - Purines: two-ring structures, adenine and guanine
   - Pyrimidines: one-ring structures, thymine (in DNA), cytosine and uracil (RNA)



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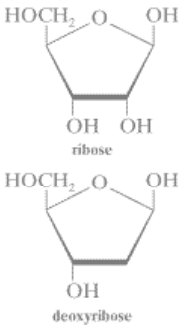
2. A pentose sugar
   - RNA - ribose
   - DNA – deoxyribose

3. A phosphate linkage derived from phosphoric acid



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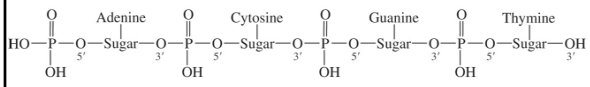
Structure of Nucleic Acids

- A nucleic acid polymer contains nucleotide chains in which the phosphate group of one nucleotide links to the sugar ring of a second.
  - The primary structure: the sequence of bases



  - ACGT

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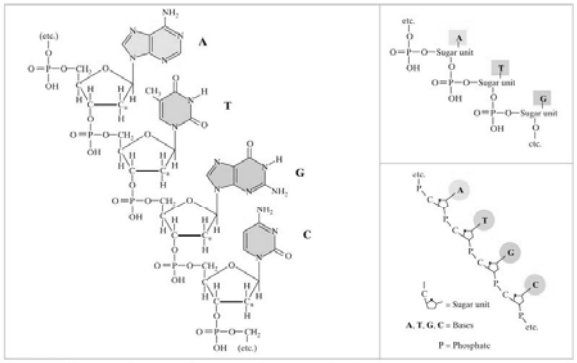

FIG. 22.23 **Nucleic acids.** A segment of a DNA chain featuring each of the four DNA bases. When the sites marked by asterisks each carry an OH group, the main "backbone" would be that of RNA. In RNA U replaces T. The insets show how simplified versions of a DNA strand can be drawn.

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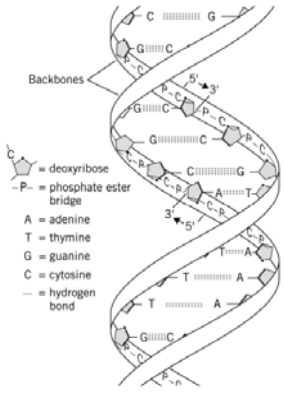

2˚ DNA Structure

- Watson and Crick (1953)
- X-ray data actually taken by Rosalind Franklin.
- 2 strands of sugar-phosphate backbones wound around in a double helix.
- Held together by hydrogen bonds between bases.
- Complimentary base pairs – the matching of bases
  - Adenine pairs with thymine
  - Guanine pairs with cytosine
  - WHY!

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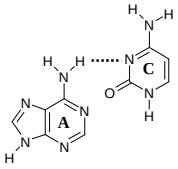
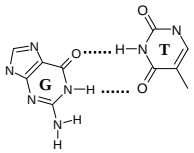


Is this going to happen????



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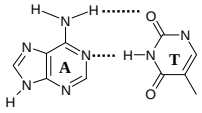
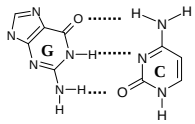


Hydrogen bonding!

Or this?



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Structure of RNA

- Similar to DNA, but…
  - Sugar is ribose (**not deoxyribose**).
  - RNA uses uracil instead of thymine.
  - RNA is much smaller.
  - RNA is usually single stranded, not double-stranded..
- Complimentary base pairing (G w/C and A w/ U) creates loops and kinks
- The principle job of RNA is to provide information to synthesize proteins.

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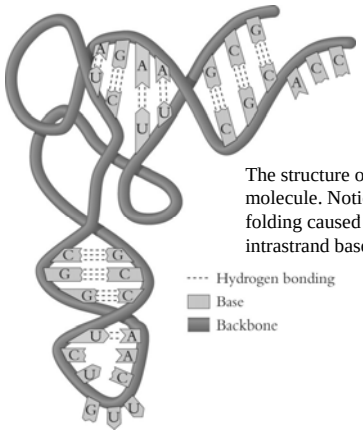

The structure of an RNA molecule. Notice the folding caused by the intrastrand base paring.

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