The Organic Molecules of Life

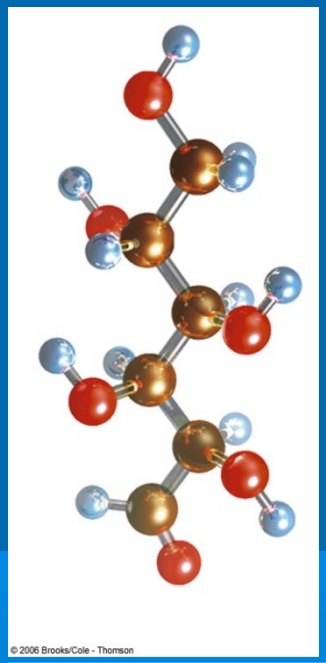
Organic Compounds

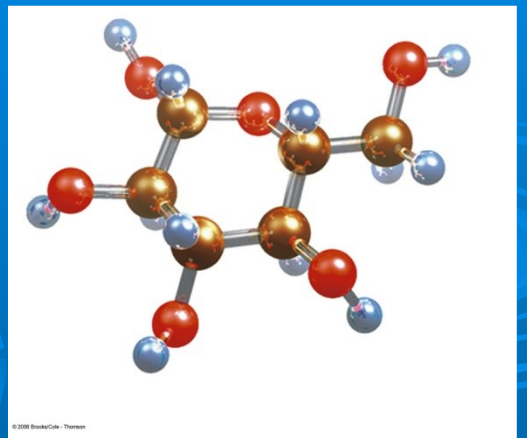
Organic molecules contain carbon and hydrogen

- Carbohydrates
- Lipids
- Proteins
- Nucleic Acids

Bonding Arrangements – the Carbon backbone!

- Carbon atoms can form chains or rings
- Other atoms project from the carbon backbone
- Why carbon? Atomic number of 6. How many electrons in outer shell?





What Cells Do to Organic Compounds

- **Metabolism**
  - Activities by which cells acquire and use energy to construct, rearrange, and split organic molecules
  - Allows cells to live, grow, and reproduce

What Cells Do to Organic Compounds

- **Condensation**
  - Covalent bonding of two molecules to form a larger molecule
  - Water forms as a product
- **Hydrolysis**
  - The reverse of condensation
  - Cleavage reactions split larger molecules into smaller ones
  - Water is split

What Cells Do to Organic Compounds

- **Monomers**
  - Molecules used as subunits to build larger molecules (polymers)

Monomers bond to form polymers in condensation reactions!

- **Polymers**
  - Larger molecules that are chains of monomers
  - May be split and used for energy

Polymers get broken down to monomers in hydrolysis reactions!

Condensation

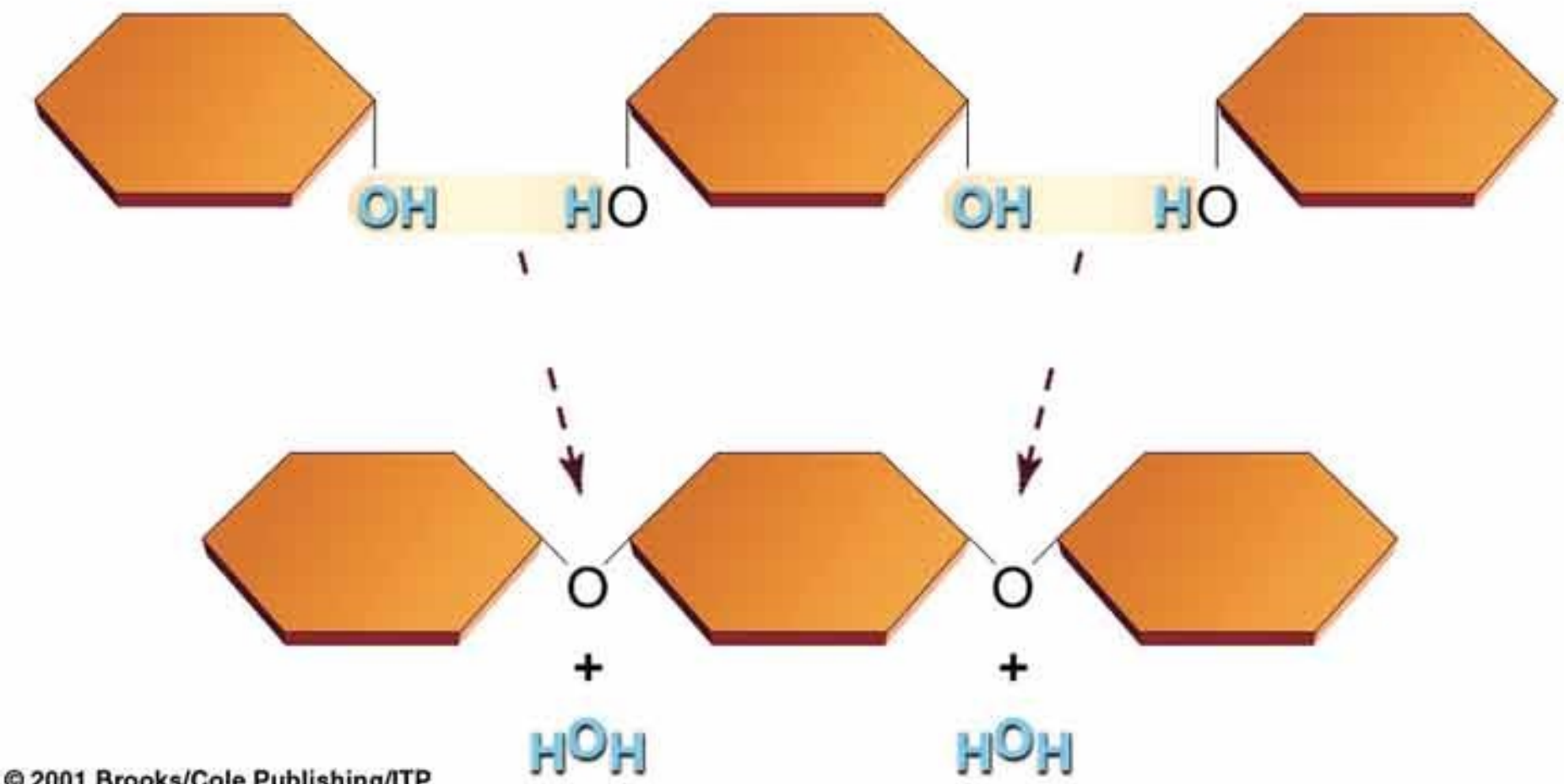


Fig. 3-6a, p.38

Hydrolysis

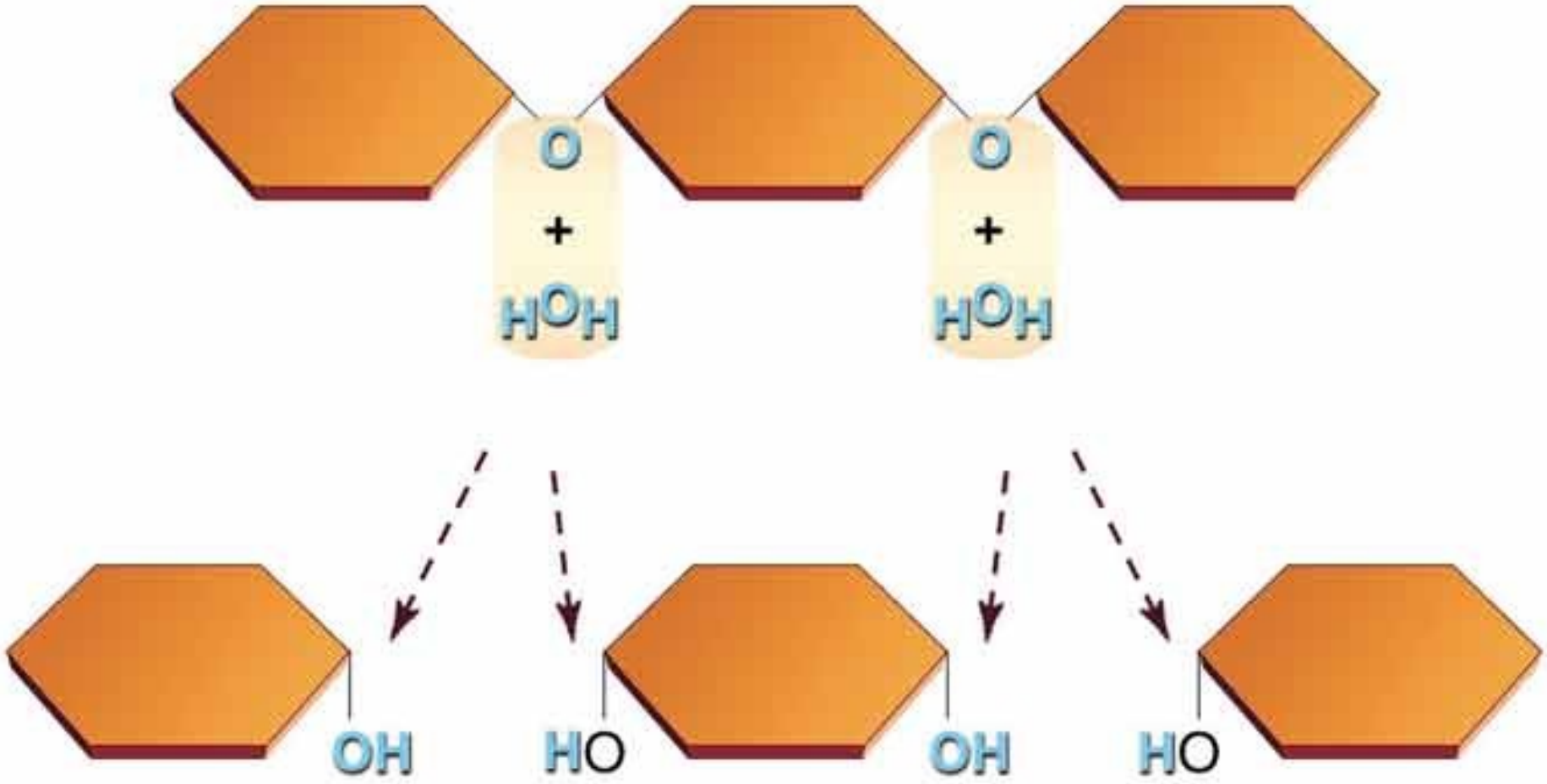


Fig. 3-6b, p.38

Organic Compounds

Hydrogen and other elements covalently bonded to carbon

- Carbohydrates – the most plentiful in nature! Used for quick energy by the body! Also can be used for structure!
- Lipids
- Proteins
- Nucleic Acids

Carbohydrates

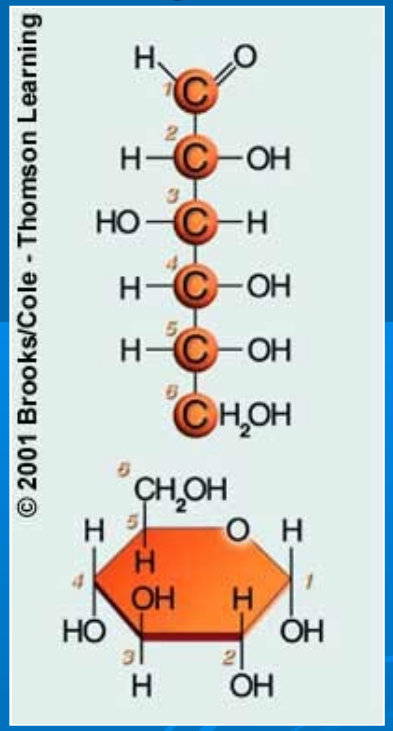
- **Carbohydrates**
  - Organic molecules that consist of carbon, hydrogen, and oxygen in a 1:2:1 ratio
  - Monosaccharides – the monomer of carbohydrates!
  - Polysaccharides – a polymer of carbohydrates!

How can you pick out a carbohydrate???
Look for the ratio!!!

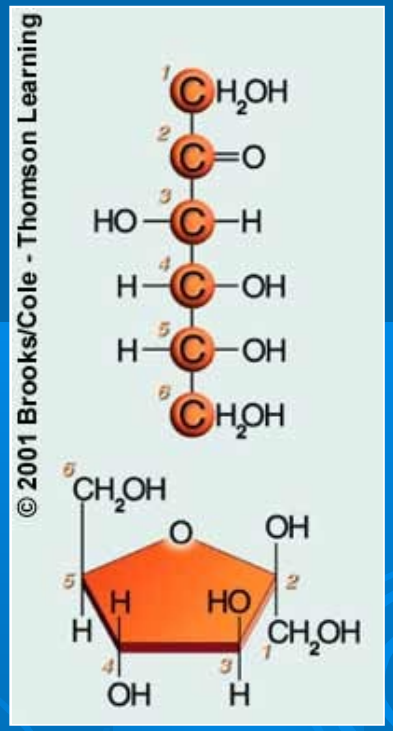
$C_6H_{12}O_6$

Monosaccharides

- Simplest carbohydrates
- Most are sweet tasting, water soluble – also called simple sugars!



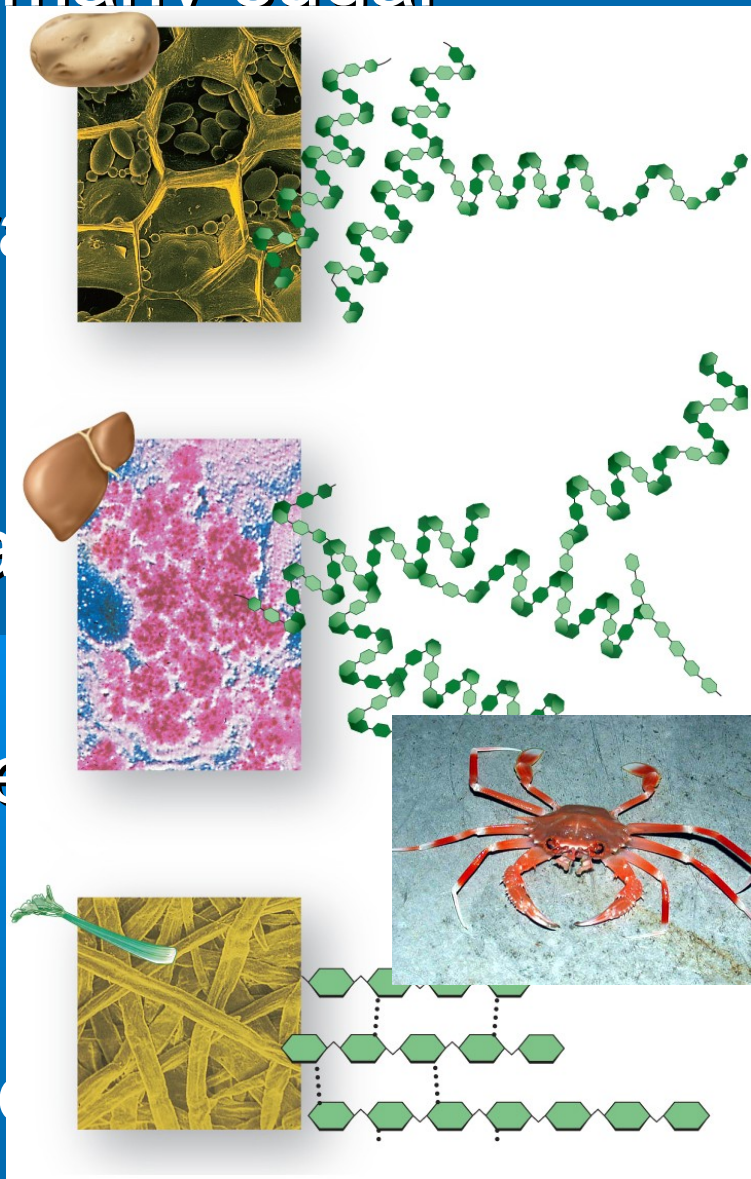
glucose



fructose

Complex Carbohydrates

- Polysaccharides - chains of many sugar monomers
- Starch - easily digested, stora plants
- Glycogen – storage form in a
- Cellulose - tough, indigestible material in plants
- Chitin – crab, lobster, insect



Organic Compounds

Hydrogen and other elements covalently bonded to carbon

- Carbohydrates
- Lipids – the greasy and oily stuff! Insoluble in water!
- Proteins
- Nucleic Acids

Greasy, Oily – Must Be Lipids

- Lipids function as
  - the body's major energy reservoir
  - the structural foundation of cell membranes
  - waterproofers

Lipids

- Most include fatty acids – the lipid monomer
  - Fats
  - Phospholipids
  - Waxes
- Sterols and their derivatives have no fatty acids

Fats

How can you pick out a lipid???
Look for the Carbon & Hydrogen!!!

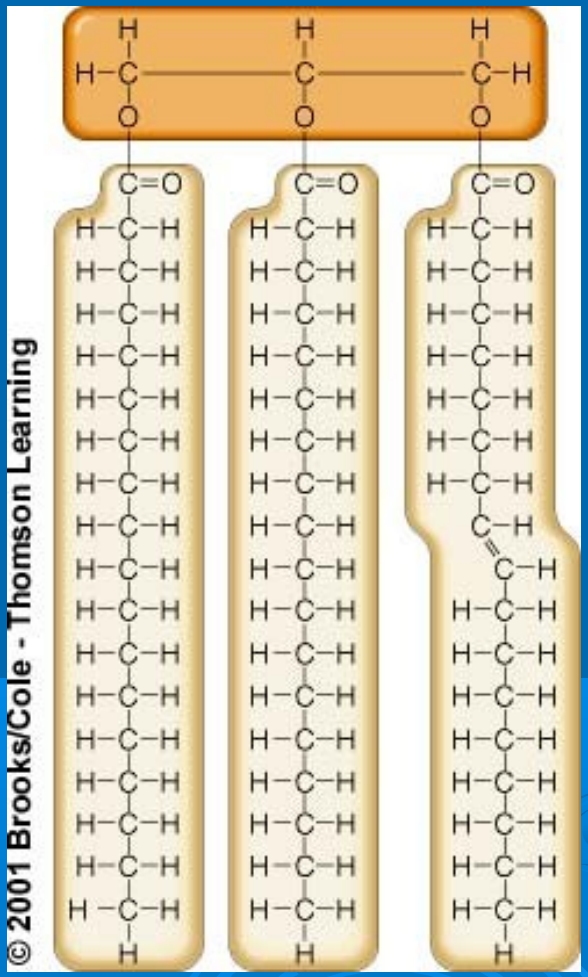
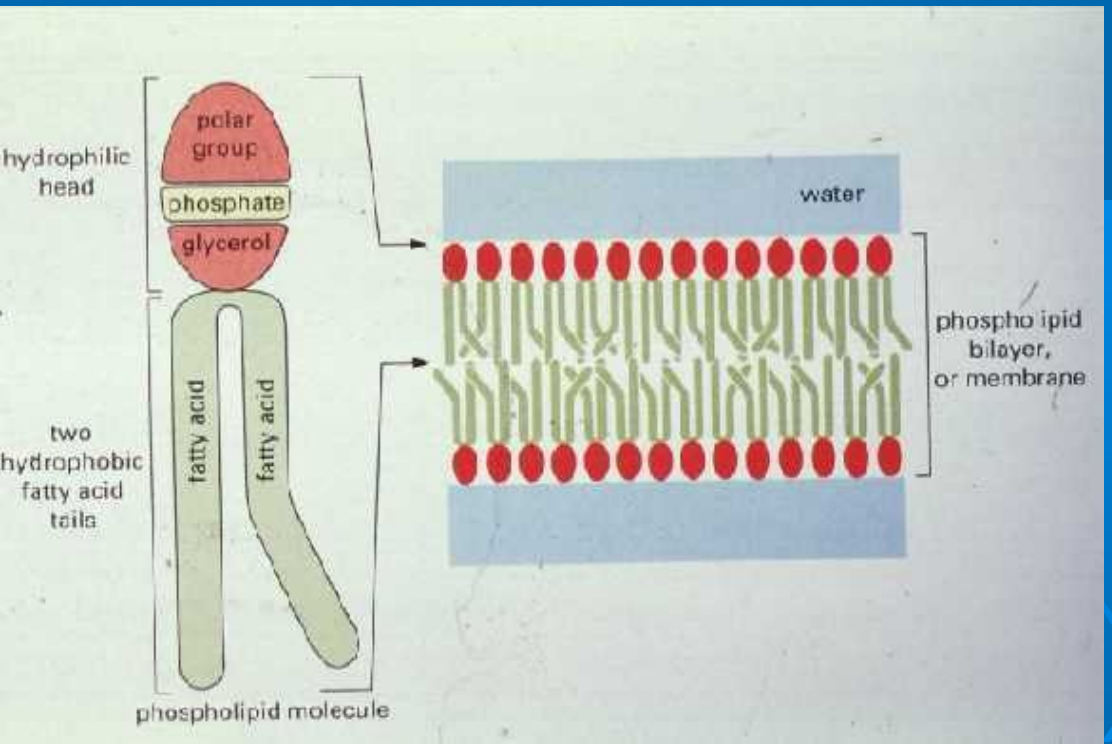
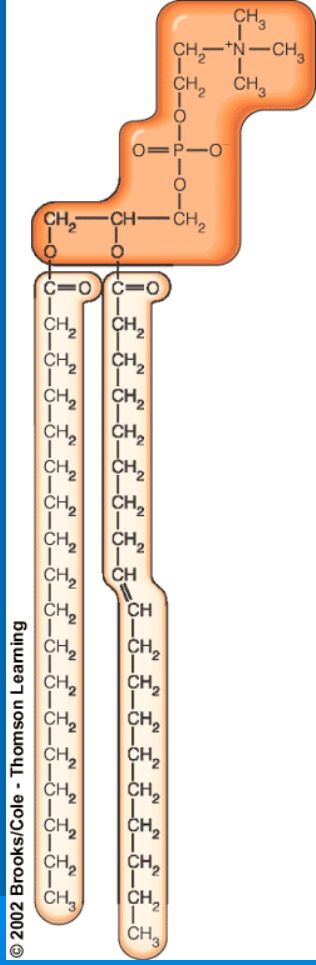


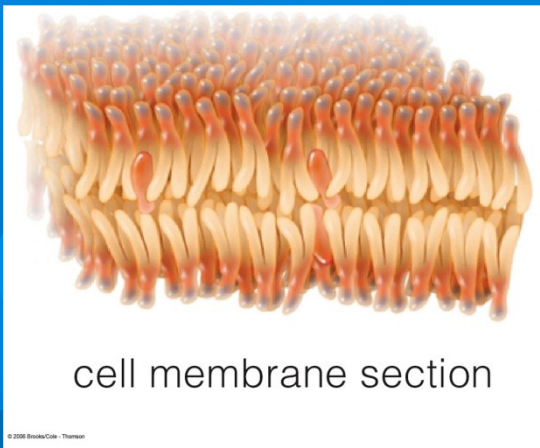
Fig. 3-12, p.40

Phospholipids

- Main components of cell membranes



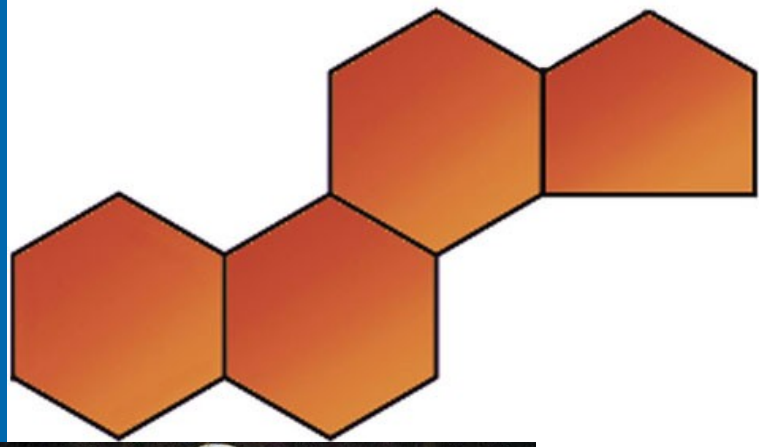




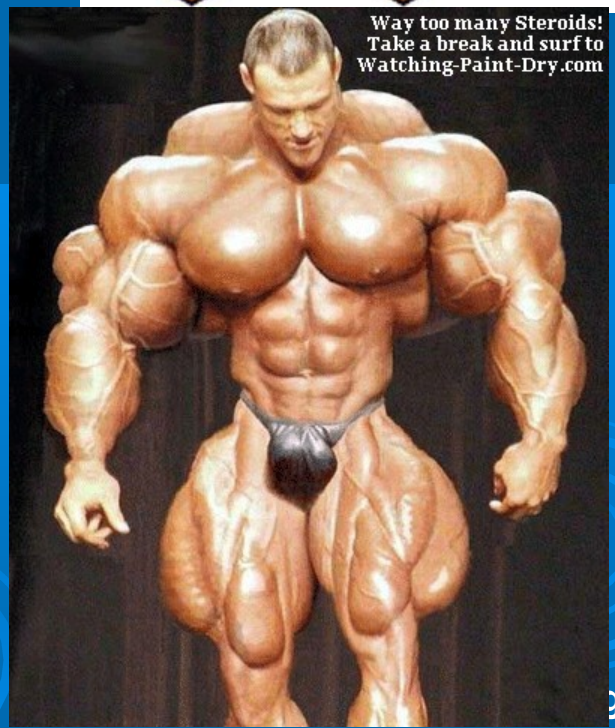
Waxes

- **Waxes**
  - Protective, water-repellant covering

Sterols and Derivatives



- No fatty acids
- Rigid backbone of four fused-together carbon rings
- Cholesterol - most common type in animals



g. 3-14, p.41

Organic Compounds

Hydrogen and other elements covalently bonded to carbon

- Carbohydrates
- Lipids
- Proteins – the most diverse in structure and function!!!
- Nucleic Acids

Diversity in Structure and Function

- Proteins are the most diverse biological molecule (structural support, metabolism, transport, defense, regulation, motion)

Proteins and Amino Acids

- **Protein**
  - An organic compound composed of one or more chains of amino acids

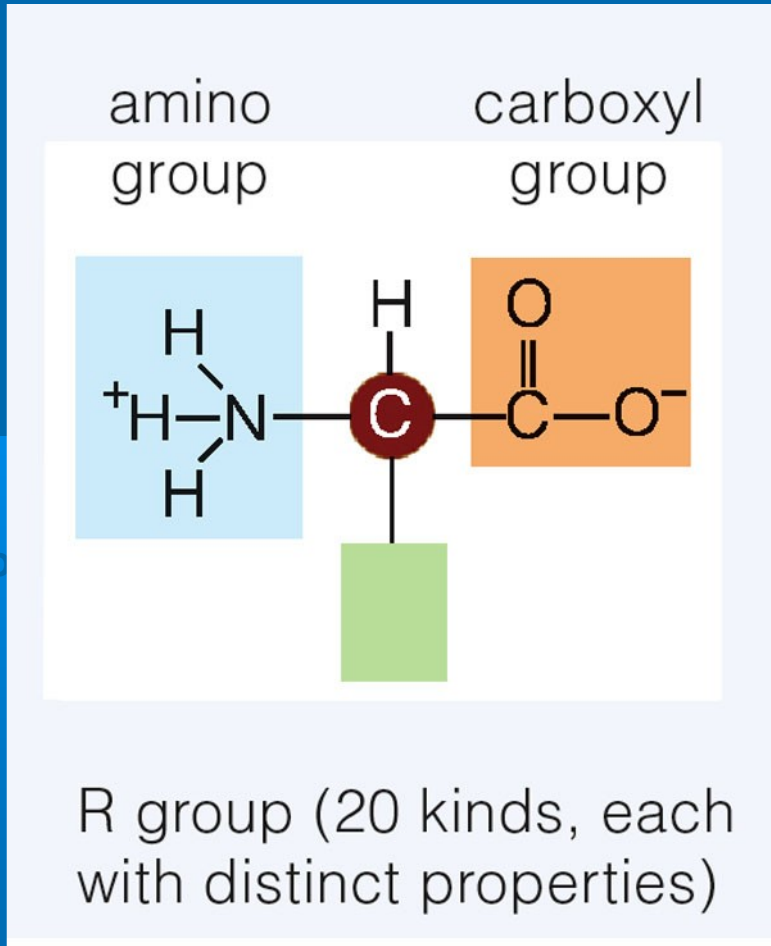
- **Amino acid – the monomer of proteins**
  - A small organic compound with an amine group (—NH_3^+), a carboxyl group (—COO^-, the acid), and one or more variable groups (R group)

Amino Acid Structure

The different R groups determines which amino acid it is!

How can you pick out an amino acid???

Look for the amino group (NH_3)!!!



Protein Synthesis

- Protein is a chain of amino acids linked by peptide bonds
- Peptide bond
  - Type of covalent bond
  - Links amino group of one amino acid with carboxyl group of next
  - Forms through condensation reaction

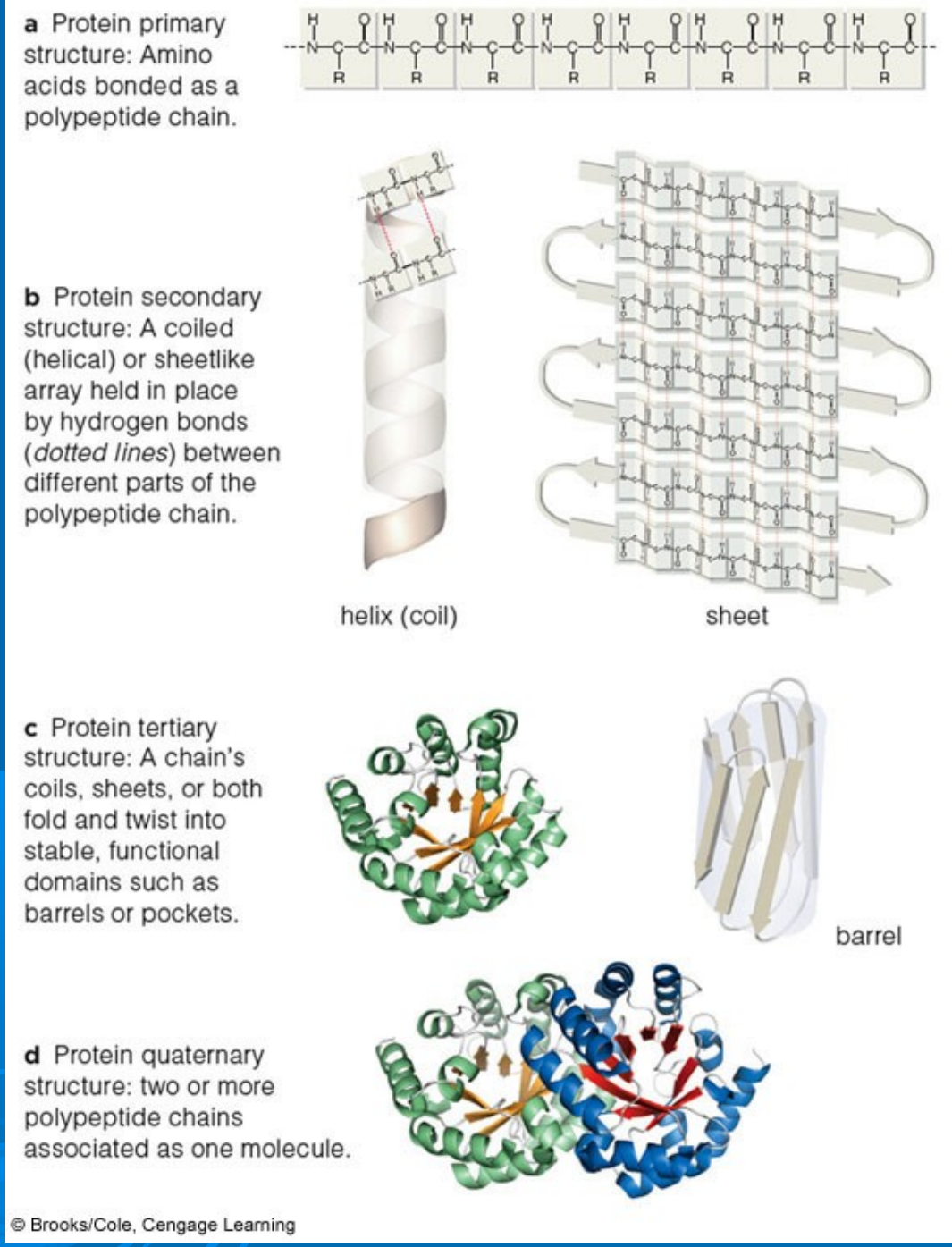
Levels of Protein Structure

- Primary structure
  - The unique amino acid sequence of a protein
- Secondary structure
  - The polypeptide chain folds and forms hydrogen bonds between amino acids

Levels of Protein Structure

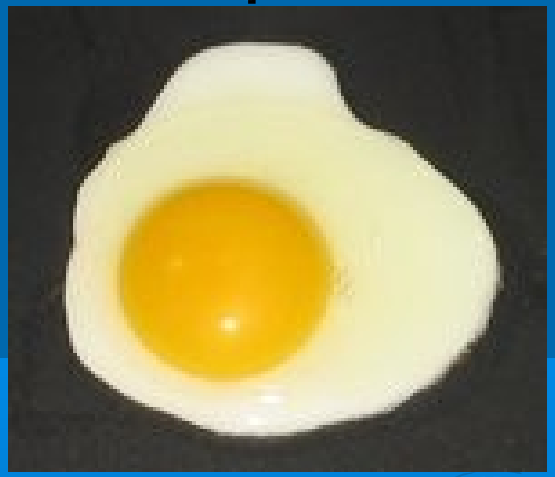
- Tertiary structure
  - Interacting secondary structures
  - Forms a functional protein
- Quaternary structure
  - Some proteins consist of two or more folded polypeptide chains in close association
  - *Example:* hemoglobin

Levels of Protein Structure



Denaturation

- Disruption of three-dimensional shape
- Breakage of weak bonds
- Causes of denaturation:
  - pH
  - Temperature
- Destroying protein shape disrupts function



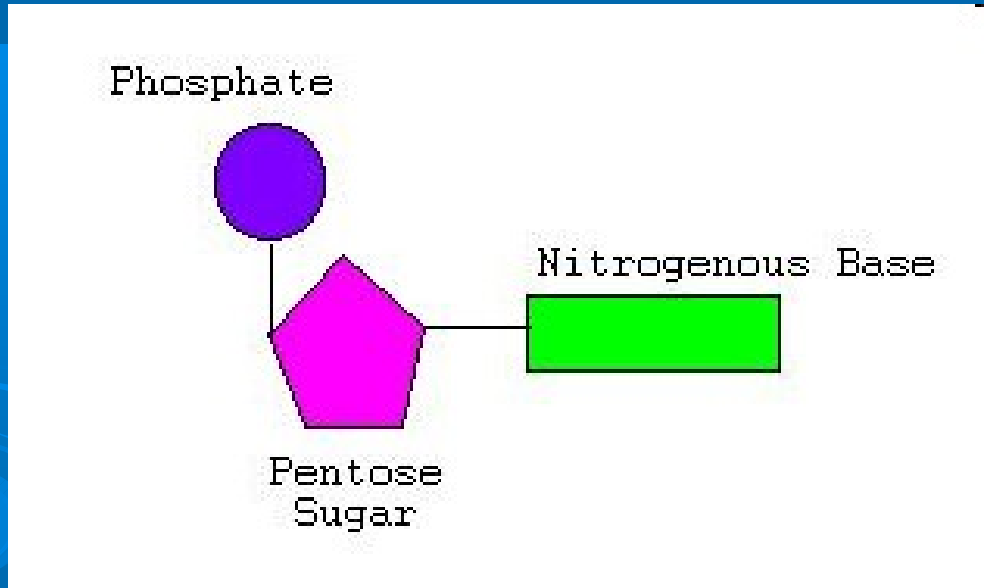
Organic Compounds

Hydrogen and other elements covalently bonded to carbon

- Carbohydrates
- Lipids
- Proteins
- Nucleic Acids – DNA (stores genetic info) and RNA (protein-maker helper)!

Nucleotide (the nucleic acid monomer) Structure

- Sugar
  - Ribose or deoxyribose
- At least one phosphate group
- Base
  - Nitrogen-containing



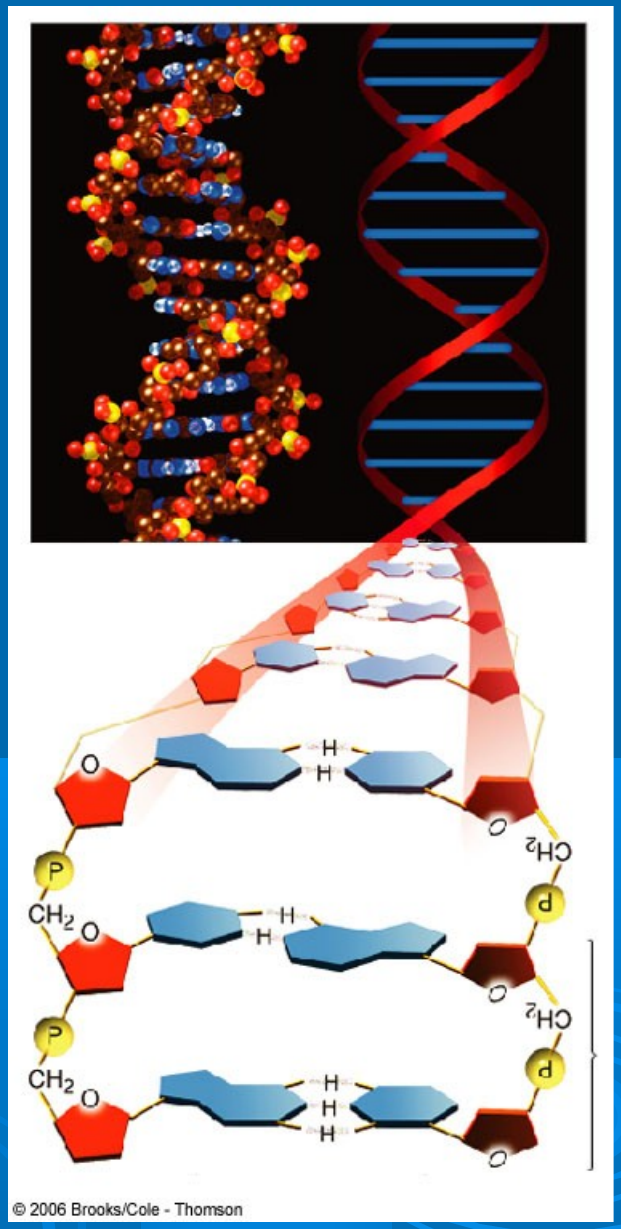
Nucleotide Functions

- Energy carriers (ATP)
- Coenzymes (NAD, FAD): they transport electrons during cellular respiration.
- Chemical messengers
- Building blocks (monomers)

  for nucleic acids (DNA, RNA)

DNA

- Double-stranded
- Consists of four types of nucleotides
- A bound to T
- C bound to G
  - Contains all inherited information necessary to build an organism, coded in the order of nucleotide bases



RNA

- Usually single strands
- Four types of nucleotides
- Unlike DNA, contains the base uracil in place of thymine
- Three types are key players in protein synthesis

Relationship between DNA & proteins – sickle cells can lead to fatalities!